# A Guide for Validating and Checking BIM Submittals

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## Background

Implementation of a robust quality control process for Building Information Model (BIM) deliverables at the Massachusetts Port Authority (MPA) is an essential step to ensure that the MPA realizes the benefits of BIM. Since 2015, MPA's BIM Guidelines for Vertical and Horizontal Construction has served as a standard for BIM delivery. The goal of this QA/QC protocol is to ensure that all projects adhere to the MPA BIM standards, in an effort to further the MPA's vision.

BIM is an essential component in realizing this mission as it is the foundation to the MPA becoming a digital, data driven, and lean organization from concept to design to construction to operations.

**Massport Vision**

*The Massachusetts Port Authority (MPA) owns and operates an integrated world-class transportation network that promotes economic growth and opportunity, enhances the quality of life of New England residents, and protects the freedom to travel safely, securely, efficiently and cost-effectively.*

## The BIM Quality Assurance / Quality Control Program

The current QA/QC process is designed to be performed at required submittal milestones such as 60% design or model turnover, to ensure that the Close-Out BIM deliverable is consistent with MPA BIM standards *(see Table 1)*. This will ensure that operations, facilities management, and future construction projects are relying on an accurate and high quality BIM. It is a critical step in achieving the MPA's goal "to have its facilities and major infrastructure assets digitally represented, including standard datasets, in an FM portfolio." This guide for validating and checking BIM submittals is intended to build a more robust structure around the "Model Review by MPA" step of the BIM Handover Process.

Future opportunities exist to:

- Extend this QA/QC protocol throughout the lifecycle of BIM implementation on MPA's capital projects.
- Analyze the data within the BIM to ensure compliance with COBie standards and integration of BIM data into facilities management systems.

# The BIM Quality Assurance / Quality Control Program (continued…)

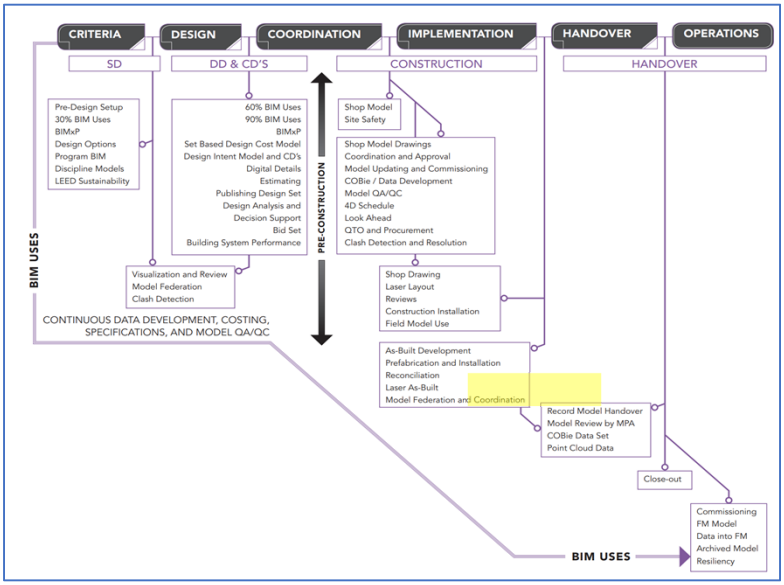



*Table 1. Massport VDC Program*

## Software Required

Checking the BIM will require the use of up to 9 software programs. These programs allow reviewers to verify and validate submittals.

Tools used for checking

- Autodesk Revit
- Autodesk Navisworks Manage
- Autodesk AutoCAD/Civil 3D
- Autodesk Recap
- Clearedge3D Verity
- File Name Checker
- Microsoft Excel
- PDF Viewer (Bluebeam, Adobe)
- Microsoft Snipping Tool or Similar

## Skills Required

Checking the BIM will require Intermediate level understanding of Autodesk Programs referenced in software tools. Use of other programs will require Fundamental-Intermediate level understanding.

## The Process

The Massport QA/QC process currently involves four reviews as described below. This ensures that geometry is submitted with the correct level of development, is in the correct location, represents an accurate system, and does not have any clash issues.

Steps on the following pages will cover instructions on how to use the QA/QC template, check model coordinates, point cloud validation, and clash detection.

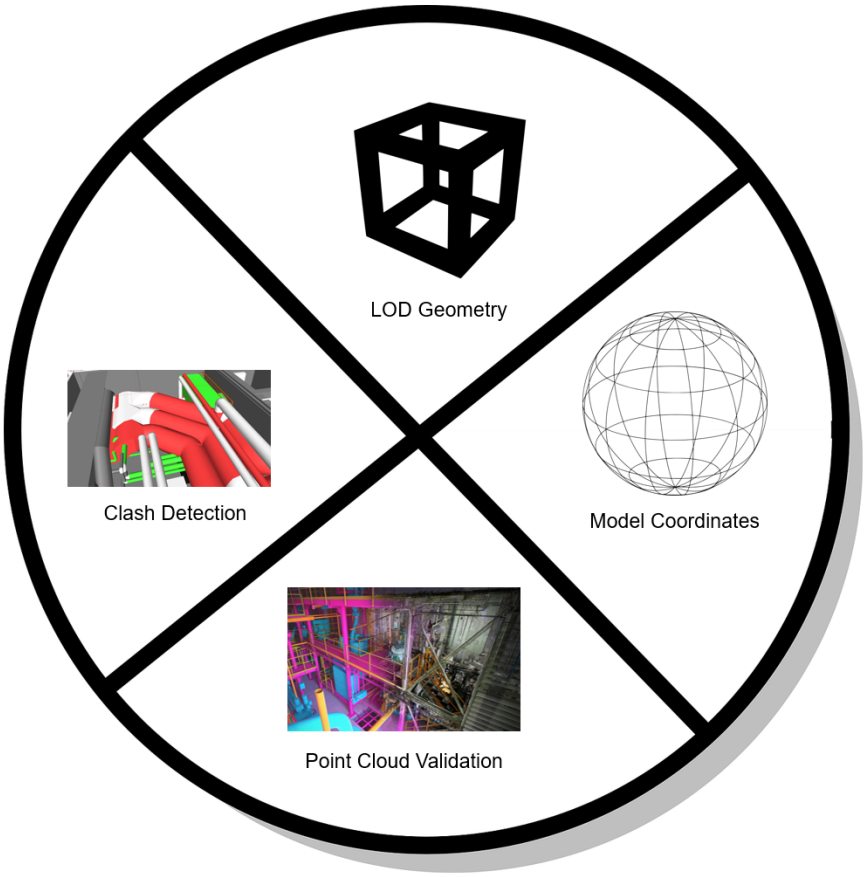



*Image 1. Components of the QA/QC Process*

# The QA/QC Template Process

## Step 1: Getting Started with Massport QAQC Protocol v1.0.zip

1.1 MPA will send the responsible reviewer a .zip folder named *Massport BIM QAQC Protocol v1.0.zip* containing the necessary BIM Quality Assurance / Quality Control files. The zip folder includes three subfolders. These subfolders are *How to Guide, Model Evaluation Template_v1.0, and QAQC Report Template* as shown in example image.

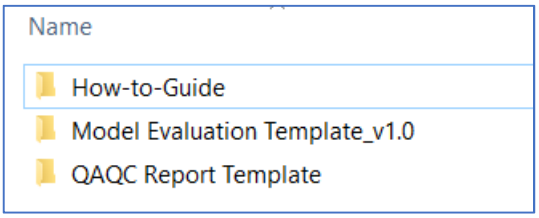



*Image 2. Contents of Massport Protocol v1.0.zip*

1.2 Reviewer should extract .zip in its' own folder specific to the review date for easy reference and saving at end of evaluation.

1.3 The folder structure, folder naming, and file naming should never be changed, so as to preserve the integrity of several built-in hyperlinks.

1.4 The "How to Guide" folder contains one file:
*A Guide for Validating and Checking BIM Submittals_v1.0.pdf*

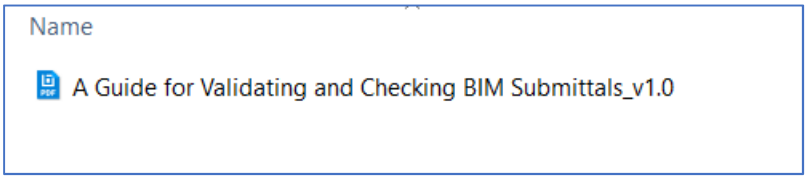



*Image 3. Contents of How to Guide Folder*

1.5 The "QAQC Report Template" folder contains one file:
*a. MPA BIM QAQC Report Template v1.0.pptx*

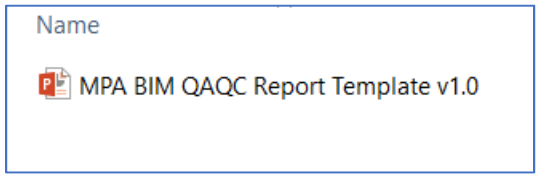



*Image 4. Contents of QAQC Report Template Folder*

# The QA/QC Template Process (continued…)

## Step 1: Getting Started with Massport QAQC Protocol v1.0.zip

1.6 The "Model Evaluation Template_v1.0" folder contains the Excel spreadsheet for evaluation and seven related folders:

a. Folder and Contents:

i. Architectural: Contains PDF documents of relevant sections of the BIMForum LOD Specification for Architectural components.

ii. Electrical and Alarm Systems: Contains PDF documents of relevant sections of the BIMForum LOD Specification for Electrical and Fire Alarm components.

iii. HVAC: Contains PDF documents of relevant sections of the BIMForum LOD Specification for Mechanical Duct and Mechanical Pipe components.

iv. Plumbing - FP: Contains PDF documents of relevant sections of the BIMForum LOD Specification for Plumbing and Fire Protection components.

v. Screenshots: This folder contains a subfolder for each discipline to save screenshots that are linked to the Excel template and used to insert into PowerPoint report template.

vi. SiteInfrastructure: Contains PDF documents of relevant sections of the BIMForumn LOD Specification for site utilities and other infrastructure components.

vii. Structural: Contains PDF documents of relevant sections of the BIMForum LOD Specification for structural components.

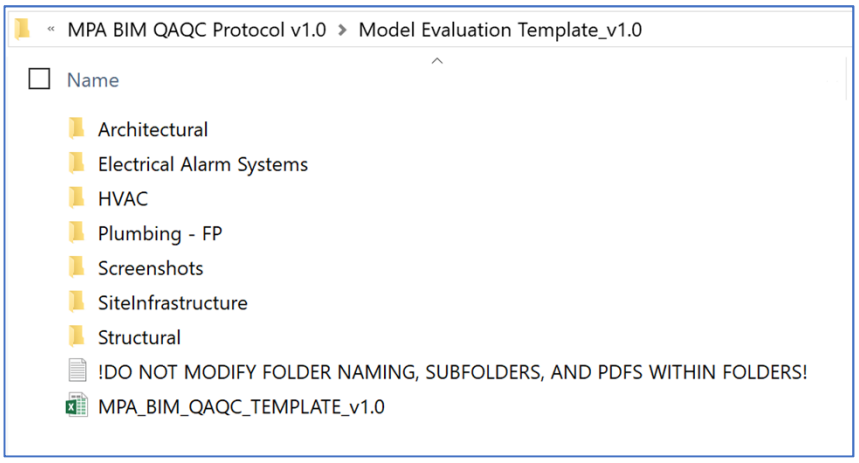



*Image 5. Model Evaluation Template_v1.0 Folder Structure*

b. All seven sub folders are linked to the following template: *MPA_BIM_QAQC_Template_v1.0.xlsx*.

This document quickly facilitates locating the relevant LOD requirements needed for the Geometry Checking (LOD) assessment.

# The QA/QC Template Process (continued…)

## Step 2: Receiving Documents for Review

2.1 MPA or selected Partner will provide the reviewer with complete documentation required to perform the review successfully.

2.2 If important items are not available, stop here and do not begin Step 3. Contact responsible parties to ensure documents have been received before starting evaluation.

The *BIMxP and Project Specifications* are most critical in ensuring a thorough and efficient review.

## Step 3: Evaluation Setup

3.1 Open *MPA_BIM_QAQC_Template_V1.0.xlsx*, found in Model Evaluation Template_v1.0 folder.

3.2 Navigate to each Red tab at the bottom of spreadsheet, starting with *1.1 - SiteInfrastructure*.

*a. Important Note: In excel template, Red Tabs indicate "working" tabs. These are used to automatically populate pivot tables referenced in step 13.*

3.3 Open *BIMxP* and *Specifications* for Project.

3.4 Carefully go through *BIMxP* and *Specifications* to determine which CSI / Uniformat categories are needed for evaluation and grey out any Uniformat rows that are not required for this review using the following directions:

i. Navigate to column "Pass/Fail"
ii. For Uniformat rows that are not required, use the dropdown and select N/A.
iii. The Uniformat row that is not required will grey out and have a slash through the rest of adjacent cells in row.

3.5 Carefully go through BIMxP and determine the specified LOD for each Uniformat row that needs to be checked on project. Use the following directions to specify BIMxP LOD for review.

i. Navigate to column "BIMxP LOD"
ii. Click the drop-down for each item and select the defined LOD from BIMxP for project.
iii. By default, each item is automatically set to 300 or 350.

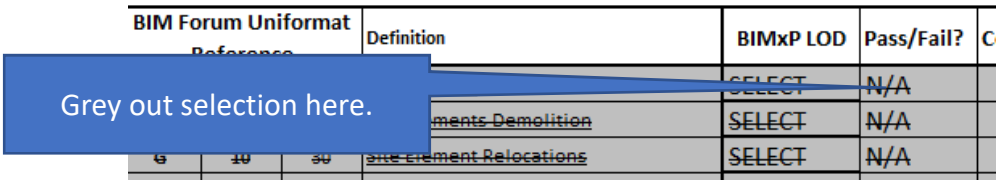



*Image 6. Excel Template – Using N/A to grey out entire row*

# The QA/QC Template Process (continued…)

## Step 3: Evaluation Setup

3.6 Perform items 3.4-5 until each Red tab has been checked against BIMxP and Specifications. Red tabs include:

*Image 7. Red Working Tabs*

i. 1.1 - Infrastructure
ii. 2.1 - Architectural
iii. 2.3 - Structural
iv. 2.4 - HVAC
v. 2.5 - Plumbing & FP
vi. 2.6 - Electrical Alarm Systems
vii. 3.6 - Mechanical Clearances

3.7 When complete, keep Excel template open for use in Step 4.

## Step 4: File Alignment Check

This step is to assist the reviewer with checking file deliverables provided in Step 2 and will be used to help populate executive summary at a later step.

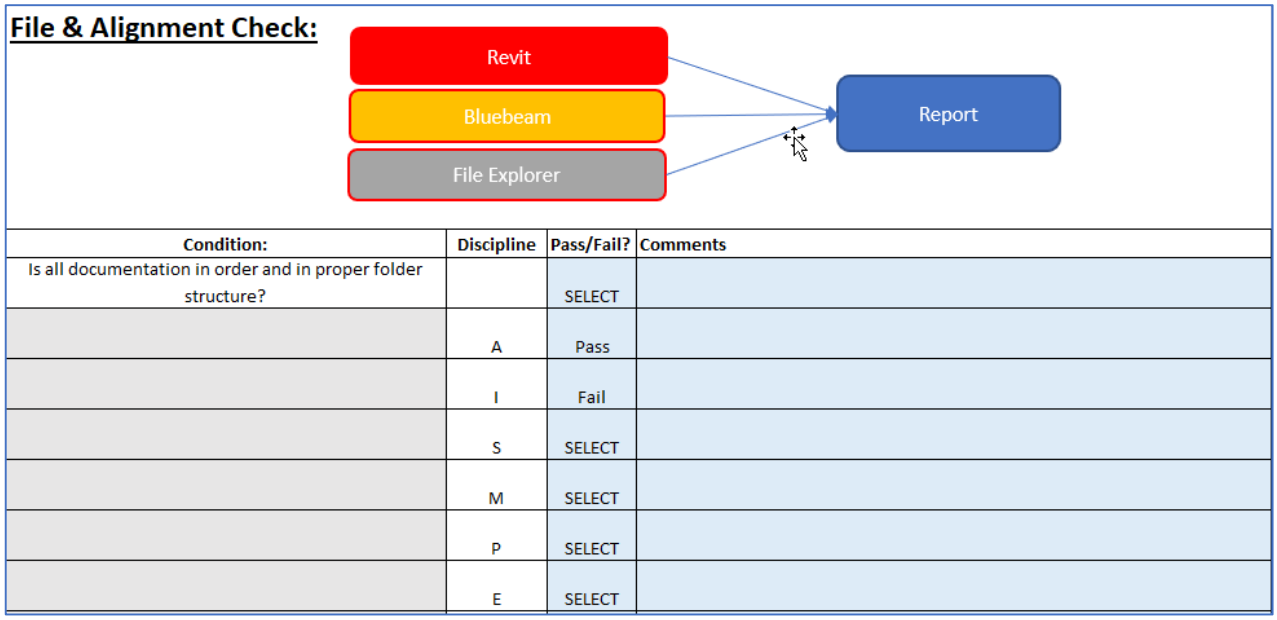
4.1 Navigate to File & Alignment Check tab of Excel template.
4.2 Open folder location where all project documents have been stored.
4.3 See “Condition:” column. There are 8 conditions to validate using File Explorer, Bluebeam, and Revit. These conditions include:
   i. Is all documentation in order and in proper folder structure?
   ii. Are file naming conventions being followed?
   iii. Are shared coordinates being followed?
   iv. Are references/linked files loaded or available?
   v. Has each model been purged?
   vi. Is sheet size correct in Revit?
   vii. Is sheet count correct in Revit?
   viii. Do sheets in Revit match PDF sheet set?
4.4 See “Discipline” Column. Each letter indicates the abbreviation for each discipline and responsible party. The list of abbreviations are provided in BIMxP. Add additional rows if the project requires more disciplines than what is shown in template.
4.5 See instructions for each condition in excel column G. Follow instructions provided and document findings in each adjacent column as stated below.
   a. Pass/Fail Column
      i. Pass – The deliverable meets the required condition.
      ii. Fail – The deliverable does not meet the required condition.
      iii. N/A – Not applicable to project. (When selected, the excel row will turn gray.)

# The QA/QC Template Process (continued…)

## Step 4: File Alignment Check

b. Comments Column
   i. Write down any important notes or comments about the model components that are being reviewed. If the item fails check, be sure to provide supporting notes in this column.

4.6 When complete, keep Excel template open for use in Step 4.5. Review inputs of file alignment check will be populated in executive summary tab at a later step.




| Condition: | Discipline | Pass/Fail? | Comments |
|---|---|---|---|
| Is all documentation in order and in proper folder structure? | | SELECT | |
| | A | Pass | |
| | I | Fail | |
| | S | SELECT | |
| | M | SELECT | |
| | P | SELECT | |
| | E | SELECT | |

*Image 8. View of File & Alignment sheet*

# The QA/QC Template Process (continued…)

## Step 5: Introduction

While evaluating, the reviewer will check the integrity of the model geometry based on the requirements set forth in the BIMxP specific to MPA projects and BIMForum LOD specifications. Specification year to be set forth in Project BIMxP and as verified by MPA *(see Table 2. LOD Requirements; Included in Appendix C)*.

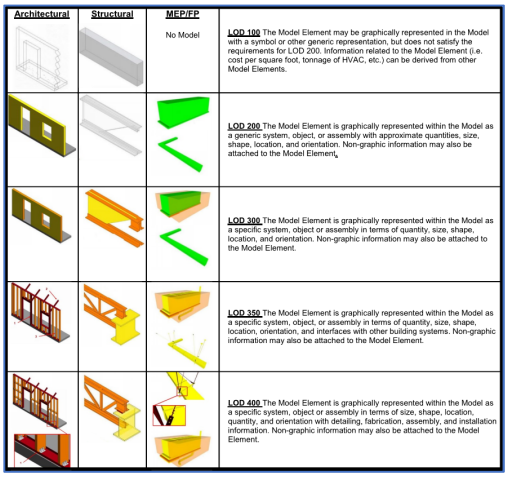

Architectural
Structural
MEP/FP
No Model
LOD 100 The Model Element may be graphically represented in the Model with a symbol or other generic representation, but does not satisfy the requirements for LOD 200. Information related to the Model Element (i.e. cost per square foot, tonnage of HVAC, etc.) can be derived from other Model Elements.
LOD 200 The Model Element is graphically represented within the Model as a generic system, object, or assembly with approximate quantities, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element.
LOD 300 The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of quantity, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element.
LOD 350 The Model Element is graphically represented within the Model as a specific system, object, or assembly in terms of quantity, size, shape, location, orientation, and interfaces with other building systems. Non-graphic information may also be attached to the Model Element.
LOD 400 The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of size, shape, location, quantity, and orientation with detailing, fabrication, assembly, and installation information. Non-graphic information may also be attached to the Model Element.

*Table 2. LOD Requirements (source: BIMForum)*

## Step 5: Geometry Checking (LOD)

5.1 1.1 - SiteInfrastructure

5.1.1 Navigate to 1.1 - SiteInfrastructure Red Tab of Excel template.

5.1.2 Open folder location(s) where Civil, Site, and Landscape construction documents, Autocad/Civil 3D files, and Navisworks Federated model are located. Open each file as needed during the next few evaluation steps .

5.1.3 Per the QA Process Steps in Excel Column J, visually verify that items are represented. Use the next step to document review findings.

5.1.4 For each open BIMForum Uniformat Reference item, perform the following:

a. Under definition, click the hyperlink next to the associated BIMForum Uniformat Reference. The Section that is being reviewed of BIMForum LOD Specification will appear in your default PDF viewer.

b. Check LOD Specification definitions for the given components that are being reviewed. Spot check different areas of the project to perform a thorough review.

c. Use the 3D view to determine the current LOD

i. Pass/Fail Column

1. Pass - The model components meet the specified BIMxP LOD definition.
2. Fail - The model components do not meet the specified BIMxP LOD definition.

ii. Current LOD Column

1. Whether Pass or Fail, click the drop-down and select the Current LOD of model that is being reviewed.

iii. Comments Column

1. Write down any important notes or comments about the model components that are being reviewed. If the item fails check, be sure to provide supporting notes in this column.

# The QA/QC Template Process (continued…)

## Step 5: Geometry Checking (LOD)

iv. Screenshots (Linked PNG) Column

1. For further explanation of pass/fail, save a screenshot of the component in question and clearly name the picture to be associated with the BIMForum Uniformat Reference.
2. To save a screenshot, use Microsoft Snipping Tool.
3. With Snipping tool open, click New and use Rectangular Selection Mode.
4. Click at two diagonal points around component in view to form the rectangle and take a screenshot.
5. Save in the specified discipline subfolder that is located inside the screenshots folder of template.
6. Name the screenshot as the BIMForum Uniformat Reference number being reviewed.
7. Once picture is saved and named, right click the associated cell in evaluation. Select Link. Navigate to the associated picture and click OK. The hyperlink will appear in cell.
8. Take note of screenshot instructions 1-7 for use in next steps of Geometry Checking (LOD).

5.1.5 Perform item 5.1.4 until each open line item is reviewed. Be sure to Save before moving on to the next evaluation section.

5.2 2.1 - Architectural

5.2.1 Navigate to 2.1 - Architectural Red Tab of Excel template.

5.2.2 Open folder location(s) where Architectural construction documents, Revit model files and Navisworks Federated model are located. Open each file as needed during the next few evaluation steps.

5.2.3 Per the QA Process Steps in Excel Column K, visually verify that items are represented. Use the next step to document review findings.

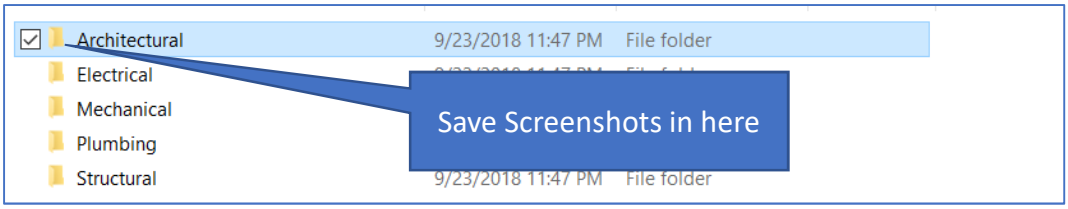



*Image 9. Screenshot Folders*

# The QA/QC Template Process (continued…)

## Step 5: Geometry Checking (LOD)

5.2.4 For each open BIMForum Uniformat Reference item, perform the following:

a. Under definition, click the hyperlink next to the associated BIMForum Uniformat Reference. The Section that is being reviewed of BIMForum LOD Specification will appear in your default PDF viewer.

b. Check LOD Specification definitions for the given components that are being reviewed. Spot check different areas of the project to perform a thorough review.

c. Use the 3D view to determine the current LOD.

i. Pass/Fail Column

1. Pass - The model components meet the specified BIMxP LOD definition.
2. Fail - The model components do not meet the specified BIMxP LOD definition.

ii. Current LOD Column

1. Whether Pass or Fail, click the drop-down and select the Current LOD of model that is being reviewed.

iii. Comments Column

1. Write down any important notes or comments about the model components that are being reviewed. If the item fails check, be sure to provide supporting notes in this column.

iv. Screenshots (Linked PNG) Column

1. See similar instructions for saving a screenshot as detailed in section 5.1.4. Reference item 5.1.4.c.iv.

5.2.5 Perform item 5.2.4 until each open line item is reviewed. Be sure to Save before moving on to the next evaluation section.

| BIM Forum Uniformat Reference | | | | Definition | BIMxP LOD | Pass/Fail? | Current LOD | Comments | Screenshots (Linked PNG) |
|---|---|---|---|---|---|---|---|---|---|
| B 20 | | | | Shell | | | | | |
| B | 20 | 10 | 0.1 | Exterior Wall Veneer | 300 | Pass | 350 | | |
| B | 20 | 10 | 0.2 | Exterior Wall Construction | 300 | Fail | SELECT | | |
| B | 20 | 10 | 0.3 | Exterior Wall Interior Skin | 300 | SELECT | SELECT | | |
| B | 20 | 10 | 0.5 | Parapets | 300 | SELECT | SELECT | | |
| ~~B~~ | ~~20~~ | ~~10~~ | ~~0.6~~ | ~~Equipment Screens~~ | ~~300~~ | ~~N/A~~ | ~~SELECT~~ | | |
| ~~B~~ | ~~20~~ | ~~20~~ | ~~.10~~ | ~~Exterior Operating Windows~~ | ~~300~~ | ~~N/A~~ | ~~SELECT~~ | | |
| ~~B~~ | ~~20~~ | ~~20~~ | ~~.20~~ | ~~Exterior Fixed Windows~~ | ~~300~~ | ~~N/A~~ | ~~SELECT~~ | | |
| B | 20 | 20 | .30 | Exterior Window Wall | 300 | Pass | 300 | Geometry looks correct per LOD 300 defintions for exterior window wall. | B2020.30_180921.PNG |
| B | 20 | 20 | .50 | Exterior Special Function Windows | 300 | SELECT | SELECT | | |
| B | 20 | 50 | .10 | Exterior Entrance Doors | 300 | SELECT | SELECT | | |

Select Current LOD

Add supporting comments

Hyperlink screenshot of pass/failed component

*Image 10. Example of Documenting LOD Findings*

# The QA/QC Template Process (continued…)

## Step 5: Geometry Checking (LOD)

5.3 2.3 - Structural

5.3.1 Navigate to 2.3 - Structural Red Tab of Excel template.

5.3.2 Open folder location(s) where Structural construction documents, Revit model files, and Navisworks Federated model are located. Open each file as needed during the next few evaluation steps.

5.3.3 Per the QA Process Steps in Excel Column K, visually verify that items are represented. Use the next step to document review findings.

5.3.4 For each open BIMForum Uniformat Reference item, perform the following:

a. Under definition, click the hyperlink next to the associated BIMForum Uniformat Reference. The Section that is being reviewed of BIMForum LOD Specification will appear in your default PDF viewer.

b. Check LOD Specification definitions for the given components that are being reviewed. Spot check different areas of the project to perform a thorough review.

c. Use the 3D view to determine the current LOD.

i. Pass/Fail Column

1. Pass - The model components meet the specified BIMxP LOD definition.
2. Fail - The model components do not meet the specified BIMxP LOD definition.

ii. Current LOD Column

1. Whether Pass or Fail, click the drop-down and select the Current LOD of model that is being reviewed.

iii. Comments Column

1. Write down any important notes or comments about the model components that are being reviewed. If the item fails check, be sure to provide supporting notes in this column.

iv. Screenshots (Linked PNG) Column

1. See similar instructions for sa ˙ g a screenshot as detailed in section 5.1.4. Reference item 5.1.4.c.iv.

5.3.5 Perform item 5.3.4 until each open line item is reviewed. Be sure to Save before moving on to the next evaluation section.

| BIM Forum Uniformat Reference | | | | Definition | BIMxP LOD | Pass/Fail? | Current LOD | Comments |
|---|---|---|---|---|---|---|---|---|
| A 10 | | | | STANDARD FOUNDATIONS | | | | |
| A | 10 | 10 | .10 | Wall Foundations (Shallow Foundations) | 300 | Pass | SELECT | |
| A | 10 | 10 | .30 | Column Foundations | 300 | Fail | SELECT | |
| A | 10 | 20 | | Special Foundations | 300 | SELECT | SELECT | |
| A | 10 | 20 | .80 | Grade Beams | 300 | SELECT | SELECT | |
| A 20 | | | | SUBGRADE ENLCOSURES | | | | |

Click to open BIMForum LOD Definition PDF

*Image 11. Example of Documenting LOD Findings*

# The QA/QC Template Process (continued…)

## Step 5: Geometry Checking (LOD)

5.4 2.4 - HVAC

5.4.1 Navigate to 2.4 - HVAC Red Tab of Excel template.
5.4.2 Open folder location(s) where Mechanical Duct/Piping construction documents, Revit model files and Navisworks Federated model are located. Open each file as needed during the next few evaluation steps.
5.4.3 Per the QA Process Steps in Excel Column K, visually verify that items are represented. Use the next step to document review findings.
5.4.4 For each open BIMForum Uniformat Reference item, perform the following:

a. Under definition, click the hyperlink next to the associated BIMForum Uniformat Reference. The Section that is being reviewed of BIMForum LOD Specification will appear in your default PDF viewer.
b. Check LOD Specification definitions for the given components that are being reviewed. Spot check different areas of the project to perform a thorough review.
c. Use the 3D view to determine the current LOD.
    i. Pass/Fail Column
        1. Pass - The model components meet the specified BIMxP LOD definition.
        2. Fail - The model components do not meet the specified BIMxP LOD definition.
    ii. Current LOD Column
        1. Whether Pass or Fail, click the drop-down and select the Current LOD of model that is being reviewed.
    iii. Comments Column
        1. Write down any important notes or comments about the model components that are being reviewed. If the item fails check, be sure to provide supporting notes in this column.
    iv. Screenshots (Linked PNG) Column
        1. See similar instructions for saving a screenshot as detailed in section 5.1.4. Reference item 5.1.4.c.iv.

5.4.5 Perform item 5.4.4 until each open line item is reviewed. Be sure to Save before moving on to the next evaluation section.

# The QA/QC Template Process (continued…)

## Step 5: Geometry Checking (LOD)

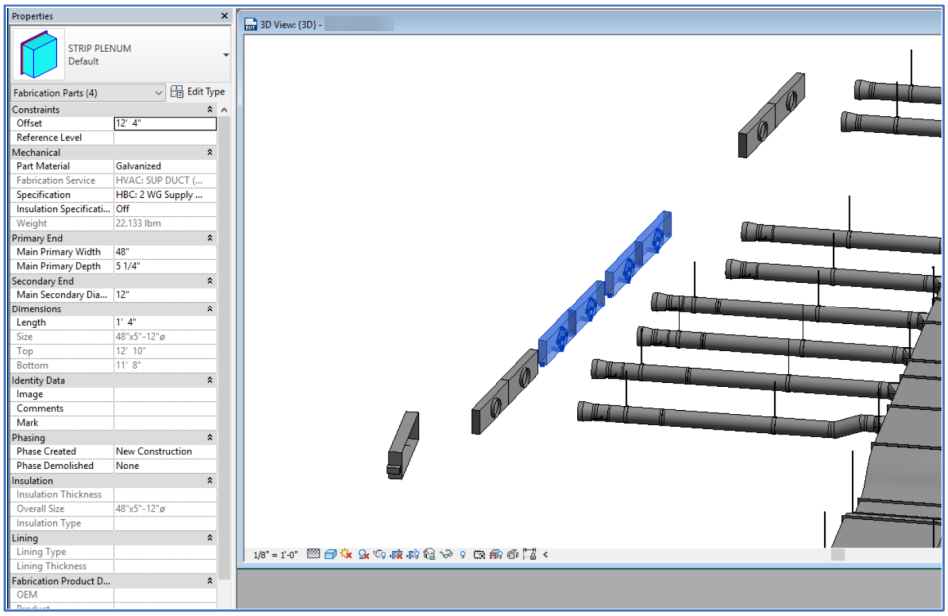



*Image 12. Example of Documenting LOD Findings*

5.5 2.5 - Plumbing & FP

5.5.1 Navigate to 2.5 – Plumbing & FP Red Tab of Excel template.

5.5.2 Open folder location(s) where plumbing/fire protection construction documents, Revit model files and Navisworks Federated model are located. Open each file as needed during the next few evaluation steps.

5.5.3 Per the QA Process Steps in Excel Column K, visually verify that items are represented. Use the next step to document review findings.

5.5.4 For each open BIMForum Uniformat Reference item, perform the following:

a. Under definition, click the hyperlink next to the associated BIMForum Uniformat Reference. The Section that is being reviewed of BIMForum LOD Specification will appear in your default PDF viewer.

b. Check LOD Specification definitions for the given components that are being reviewed. Spot check different areas of the project to perform a thorough review.

# The QA/QC Template Process (continued…)

## Step 5: Geometry Checking (LOD)

c. Use the 3D view to determine the current LOD.
    i. Pass/Fail Column
        1. Pass - The model components meet the specified BIMxP LOD definition.
        2. Fail - The model components do not meet the specified BIMxP LOD definition.
    ii. Current LOD Column
        1. Whether Pass or Fail, click the drop-down and select the Current LOD of model that is being reviewed.
    iii. Comments Column
        1. Write down any important notes or comments about the model components that are being reviewed. If the item fails check, be sure to provide supporting notes in this column.
    iv. Screenshots (Linked PNG) Column
        1. See similar instructions for saving a screenshot as detailed in section 5.1.4. Reference item 5.1.4.c.iv.

5.5.5 Perform item 5.5.4 until each open line item is reviewed. Be sure to Save before moving on to the next evaluation section.

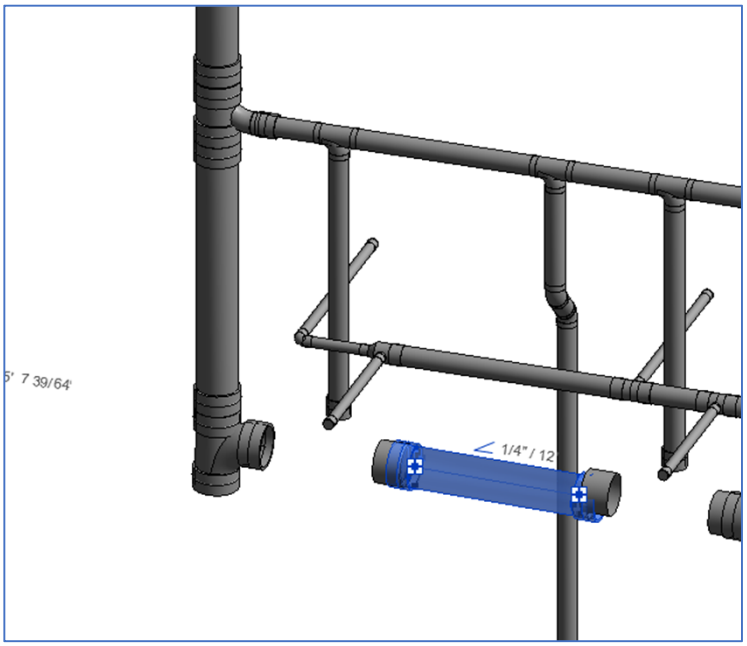



*Image 13. Plumbing Screenshot Example*

# The QA/QC Template Process (continued…)

## Step 5: Geometry Checking (LOD)

5.6 2.6 - Electrical Alarm Systems

5.6.1 Navigate to 2.6 – Electrical Alarm Systems Red Tab of Excel template.

5.6.2 Open folder location(s) where electrical/fire alarm/telecom construction documents, Revit model files and Navisworks Federated model are located. Open each file as needed during the next few evaluation steps.

5.6.3 Per the QA Process Steps in Excel Column K, visually verify that items are represented. Use the next step to document review findings.

5.6.4 For each open BIMForum Uniformat Reference item, perform the following:

a. Under definition, click the hyperlink next to the associated BIMForum Uniformat Reference. The Section that is being reviewed of BIMForum LOD Specification will appear in your default PDF viewer.

b. Check LOD Specification definitions for the given components that are being reviewed. Spot check different areas of the project to perform a thorough review.

c. Use the 3D view to determine the current LOD.

   i. Pass/Fail Column

      1. Pass - The model components meet the specified BIMxP LOD definition.
      2. Fail - The model components do not meet the specified BIMxP LOD definition.

   ii. Current LOD Column

      1. Whether Pass or Fail, click the drop-down and select the Current LOD of model that is being reviewed.

   iii. Comments Column

      1. Write down any important notes or comments about the model components that are being reviewed. If the item fails check, be sure to provide supporting notes in this column.

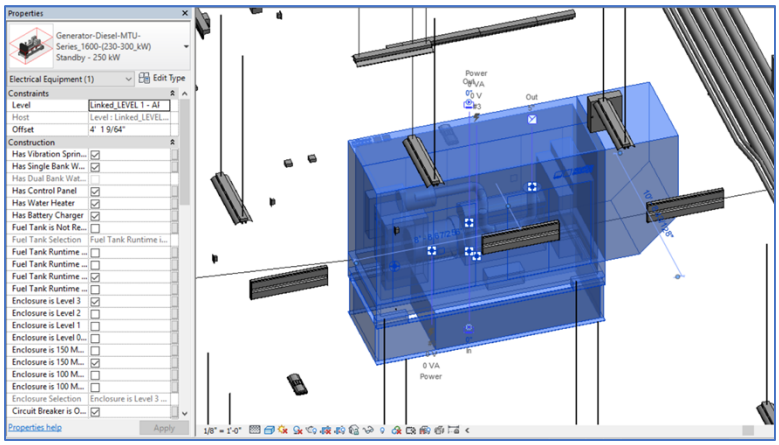



*Image 14. Electrical Screenshot Example*

# The QA/QC Template Process (continued…)

## Step 5: Geometry Checking (LOD)

iv. Screenshots (Linked PNG) Column
1. See similar instructions for saving a screenshot as detailed in section 5.1.4. Reference item 5.1.4.c.iv.

5.6.5 Perform item 5.6.4 until each open line item is reviewed. Be sure to Save before moving on to the next evaluation section.

5.7 3.6 - Mechanical Clearances

5.7.1 Navigate to 3.6 – Mechanical Clearance Red Tab of Excel template.
5.7.2 Open folder location(s) where mechanical/plumbing/electrical construction documents, Revit model files and Navisworks Federated model are located. Open each file as needed during the next few evaluation steps.
5.7.3 Per the QA Process Steps in Excel Column H, visually verify that items are represented. Use the next step to document review findings.
5.7.4 In Revit, create schedules for mechanical, plumbing, and electrical equipment with parameters required to evaluate LOD of clearances.
5.7.5 In Revit, open a 3D view and ensure that Detail Level is set to Fine, phases are set to Showing All, and all model categories are visible.
5.7.6 Tile open views and show the 3D view and schedule side by side.
5.7.7 Visually inspect to check that clearance spaces have been modeled and labeled correctly.
5.7.8 For each condition, perform the following to document findings:
a. Use the 3D view to determine the current LOD.
i. Pass/Fail Column
1. Pass - The model components meet the specified BIMxP LOD definition.
2. Fail - The model components do not meet the specified BIMxP LOD definition.
ii. Current LOD Column
1. Whether Pass or Fail, click the drop-down and select the Current LOD of model that is being reviewed.
iii. Comments Column
1. Write down any important notes or comments about the model components that are being reviewed. If the item fails check, be sure to provide supporting notes in this column.
iv. Screenshots (Linked PNG) Column
1. See similar instructions for saving a screenshot as detailed in section 5.1.4. Reference item 5.1.4.c.iv.

# Model Coordinates

## Step 6: Coordinate Check

As part of the alignment check, the reviewer should check the location of models. Read through the next two items and document findings using instruction in item 3.

6.1 Site Coordinates - Open and check all project Revit files to validate the use of proper coordinates in Revit as shown on *Image 9*.

a. To load the coordinates, type “V then G” in Revit, click on Model Categories->Site and then check “Project Base Point” to turn it on in the current view.

b. In the model, look for a circle with an X, and click on it. The coordinate point should show up. This value should be in the 2000000 range for the N/S value and the 700000 range for the E/W value.

c. Additionally, the reviewer can check the project location by clicking on Manage ->Location and then verify that the project is located in the correct location.

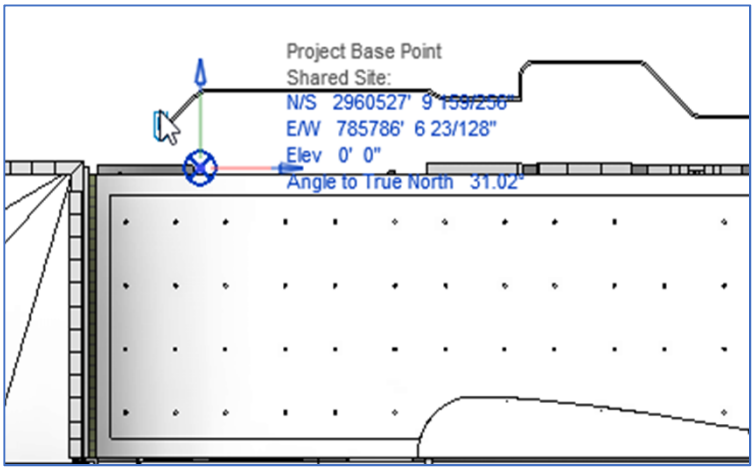



*Image 15. Architectural Model Coordinate Example*

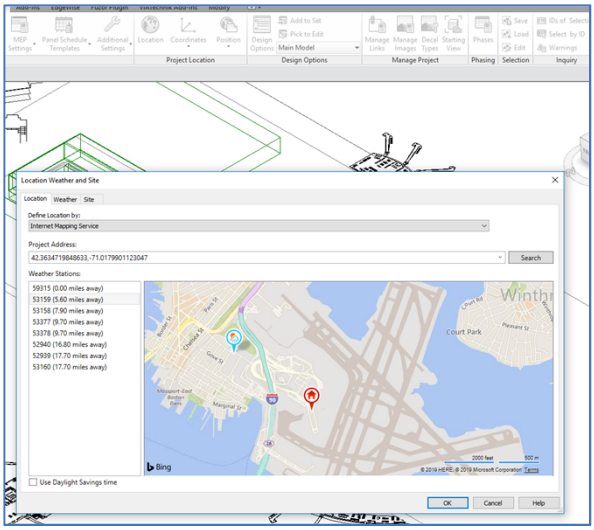



*Image 16. Project Location*

# Model Coordinates (continued…)

## Step 6: Coordinate Check

6.2 The reviewer should check for the use of proper coordinates in Navisworks or Revit – a site coordinate point was used at each Level of the Federated Record Navis model as shown in the example on *Image 11*. Additionally, in Navisworks, display the position readout to confirm that the correct coordinates are being used.

a. To do this, click on View->HUD-> Display Position Readout. The values on the lower left side of the Navisworks window should be in the vicinity of the Revit Site Coordinates.

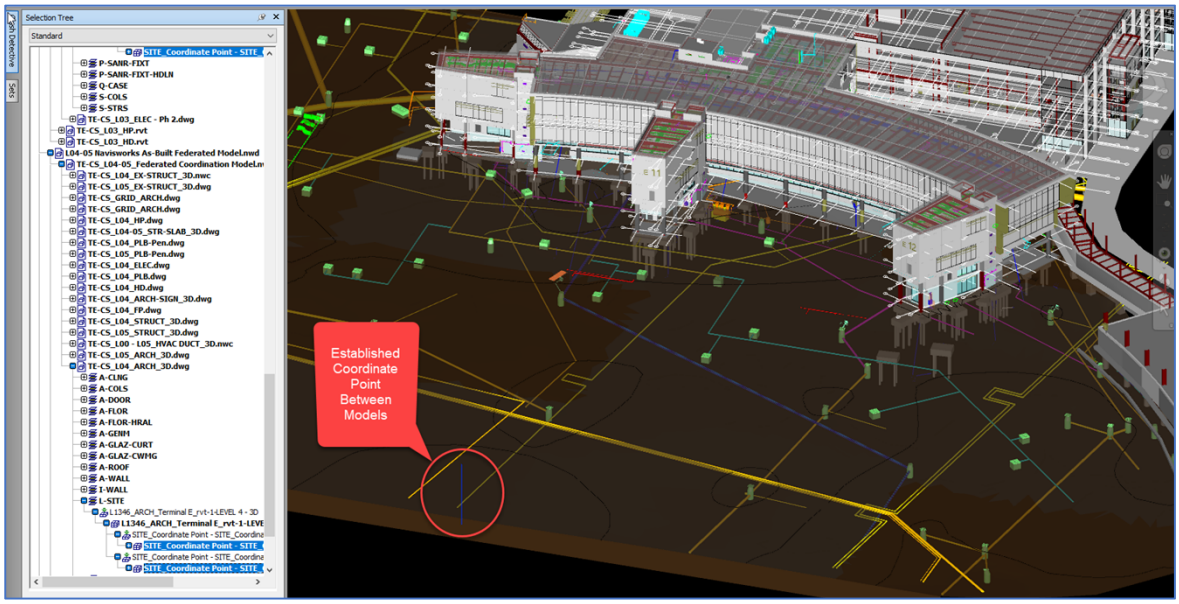



*Image 17. Navisworks Model Coordinate Example*

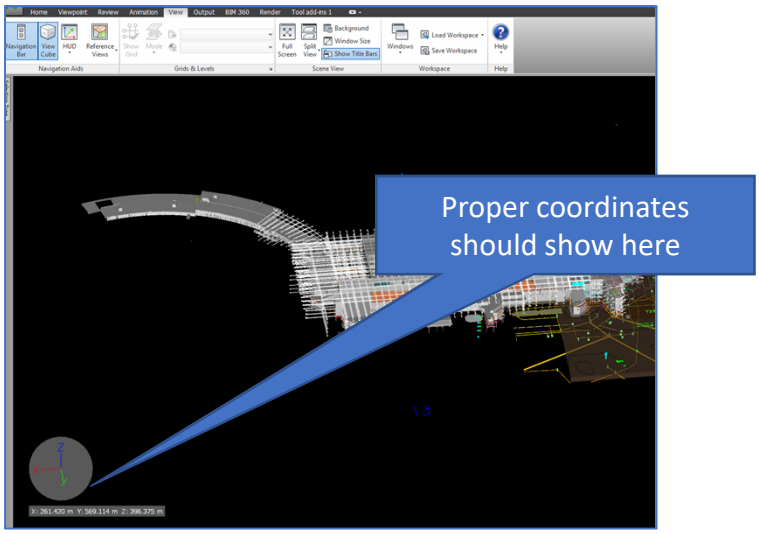



*Image 18. Coordinate Readout*

# Model Coordinates (continued…)

## Step 6: Coordinate Check

6.3 After reading through steps 1 and 2, check each major discipline's model and document your findings as follows:

i. Navigate to Coordinate Check tab of Excel template.
ii. Open each major disciplines Revit model and open Navisworks Federated Model.
iii. Check the coordinates first in Revit, then in Navisworks as a secondary step if shared coordinates aren't being followed in Revit project. If Revit shared coordinate is not being used, export the Revit model as .NWC and append into Navisworks Federated model as a final check.
iv. Use the Excel table to document what is showing in review. (See INSERT IMAGE # below).
    i. Add review findings in cell next to each major discipline where it states [Enter Text]
    ii. Depending on success of alignment in Revit and Navisworks, change the cell color of discipline as follows:
        i. Using common Cell Styles of Excel, change to:
            i. Good (Green): Shared Coordinates used in Revit.
            ii. Neutral (Yellow): Shared Coordinates not used in Revit. Aligns in Navisworks when exported.
            iii. Bad (Red): Shared Coordinates are not being used. Does not align and export correctly into Navisworks.

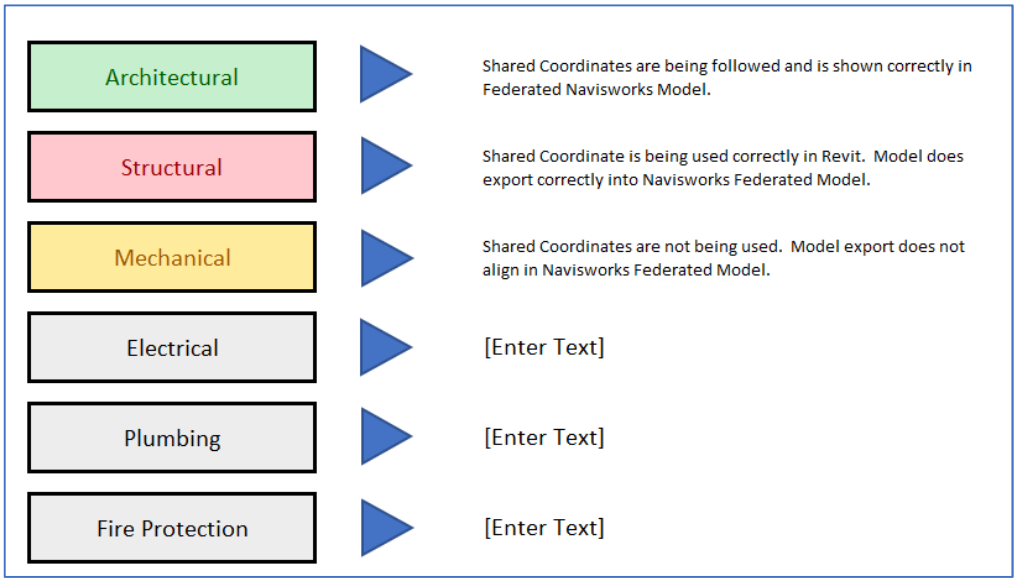

Architectural
Shared Coordinates are being followed and is shown correctly in Federated Navisworks Model.
Structural
Shared Coordinate is being used correctly in Revit. Model does export correctly into Navisworks Federated Model.
Mechanical
Shared Coordinates are not being used. Model export does not align in Navisworks Federated Model.
Electrical
[Enter Text]
Plumbing
[Enter Text]
Fire Protection
[Enter Text]

*Image 19. Coordinate Excel Table*

# Point Cloud Validation

## Step 7: Point Cloud Check

In this review, it is important to verify that point clouds are properly aligned with model geometry in Navisworks and Recap. To help automate the process, the reviewer may use Clearedge3D Verity to check alignment (not included in these instructions).

7.1 The first step of the review requires building a master NWF in Navisworks.

a. For each model being reviewed, export an NWC from the authoring software (Revit, AutoCAD, etc).

b. Open Navisworks Manage and append in the various NWCs and point cloud (RCP file or individual RCS files).

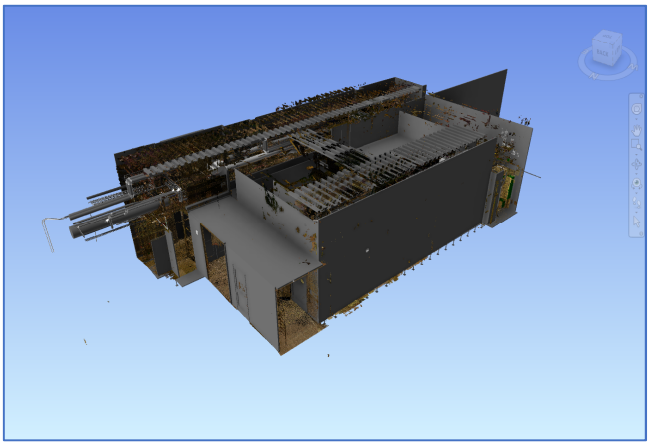


*Image 20. Loaded Navisworks files*

7.2 Cut a Plan View Section

a. Create a top and bottom section plane and space the two planes 5 feet apart.

b. Slide the blue arrow up and down to compare horizontal plane sections of the model being reviewed to the point cloud.

c. Create view points in Navisworks that identify discrepancies between the model and point cloud inside the active view range.

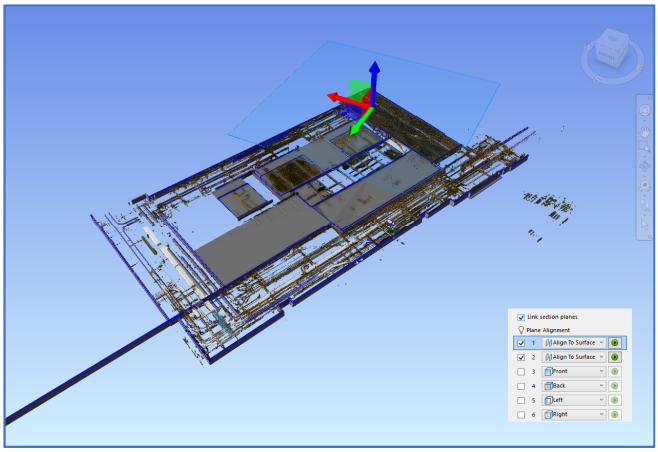


*Image 21. Plan section*

# Point Cloud Validation (continued..)

## Step 7: Point Cloud Check

7.3 Cut a Vertical Section View

a. Create North and South section planes and space the two planes 10 feet apart.
b. Slide the blue arrow left and right to compare vertical plane sections of the model being reviewed to the point cloud.
c. Create view points in Navisworks that identify discrepancies between the model and point cloud.

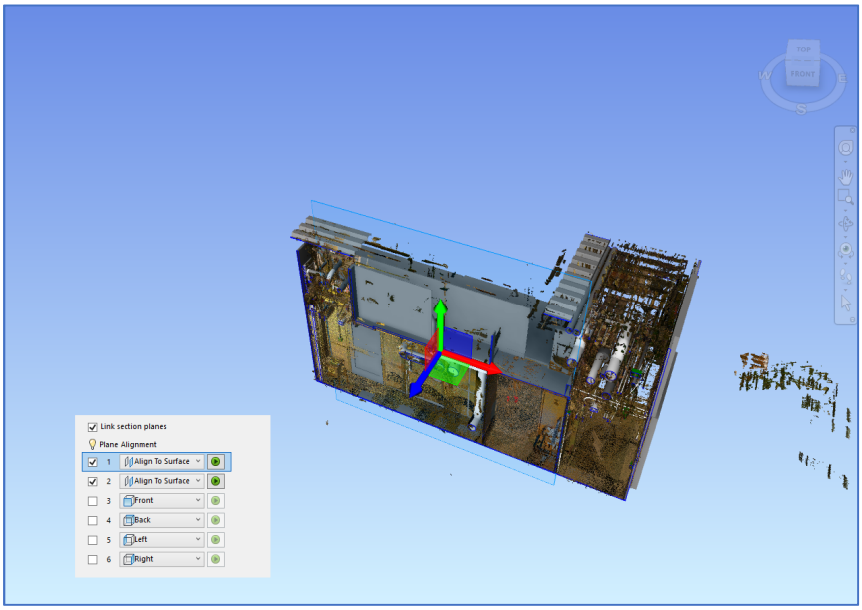



*Image 22. Vertical Section*

7.4 Check the model for constructability

a. Hide the point cloud from view and fly around the model to visually review the model quality.
b. The reviewer should look for walls that don't connect to floors, floating model elements, disconnected model elements, walls that don't join, windows that don't attach to walls, and other model items that do not reflect possible as-built conditions.
c. Create viewpoints for any model issues.

7.5 Export Viewpoints

a. When point clouds have been thoroughly checked, save Navisworks Document and Export Saved Viewpoints in *Screenshots* subfolder, titled *Point Cloud*.

# Clash Detection

## Step 8: Clash Detection

Clash detection is an important step to ensure the model is free of constructability issues, after all. The model should reflect the as-built conditions and therefore should be free of clashes.

In order to run clash detection, the Federated Model must be available or all files must first be combined to create a Federated Model. All Record As-Built Submittals are required to include a Federated Model in Navisworks NWD format. However, if the submittal is missing this requirement, the reviewer should export NWCs from the model authoring software and combine these NWCs in Navisworks Manage as you may have done in Step 7.

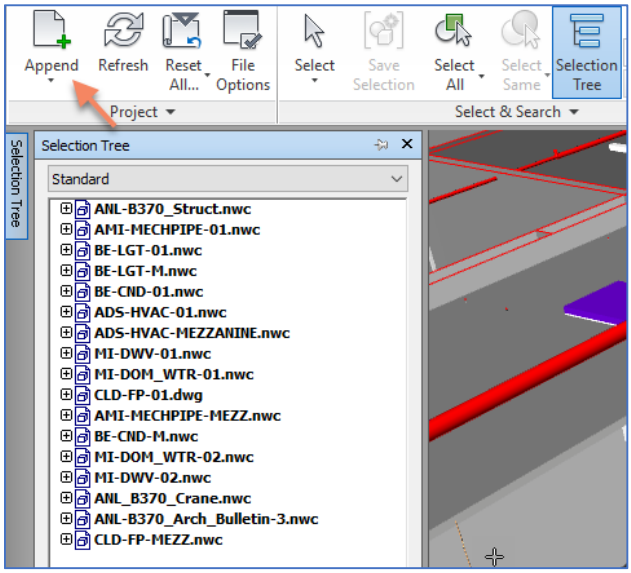



*Image 23. Selection Tree*

8.1 Prior to setting up the clash detective test, develop a clash matrix of clash test combinations like the one shown below.

a. Divide the matrix in half diagonally and place a mark on the top right side of the division. This indicates the necessary combinations of tests needed for your clash testing.

| | Duct | Mech Pipe | Electrical | Plumbing | Fire Protection | Structure |
|---|---|---|---|---|---|---|
| **Duct** | | X | X | X | X | X |
| **Mechanical Pipe** | | | X | X | X | X |
| **Electrical** | | | | X | X | X |
| **Plumbing** | | | | | X | X |
| **Fire Protection** | | | | | | X |
| **Structure** | | | | | | |

*Image 24. Clash Matrix*

# Clash Detection (continued..)

## Step 8: Clash Detection

8.2 Once the Clash Matrix is created, you can begin creating the clash tests in Navisworks Manage's Clash Detective.

a. Click Clash Detective, then, in the active window, click Add Test

b. Name the clash test, and select the models or sets to run the clash against. Use the clash matrix previously developed to determine all combinations of clash tests that are created.

c. Break these clashes out by floor as necessary and set tolerance distance in which the clash test will report a clash. The recommended distance is 1/4".

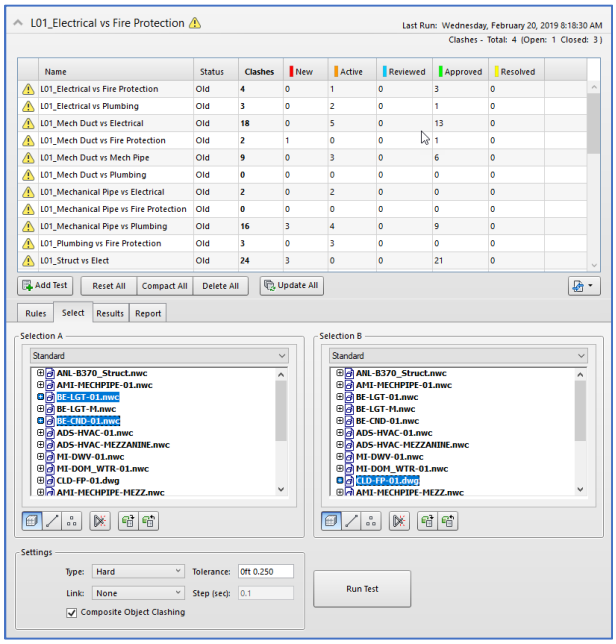



*Image 25. Clash Tests*

8.3 Understanding the Overall Clash Status

a. After a test is run, clashes should be observed from an overall view to understand the general report of the clash.

b. Select all the individual clashes by holding shift and selecting all the clashes in the list. Then, click *group selected clashes*. By grouping the clashes, the view will now show all the clashes within the test in a single view.

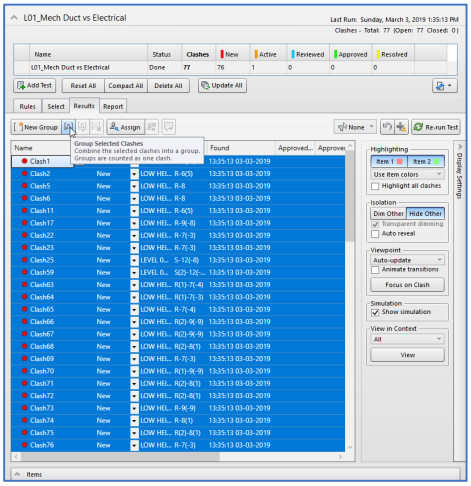



*Image 26. Clash Results*

# Clash Detection (continued..)

## Step 8: Clash Detection

c. Once the clashes are grouped in a single group, click *hide other* and observe the overall clashes in the view. Using this view, observe the clashes and understand what makes up the clashes – false positives, major clashes, or minor clashes.

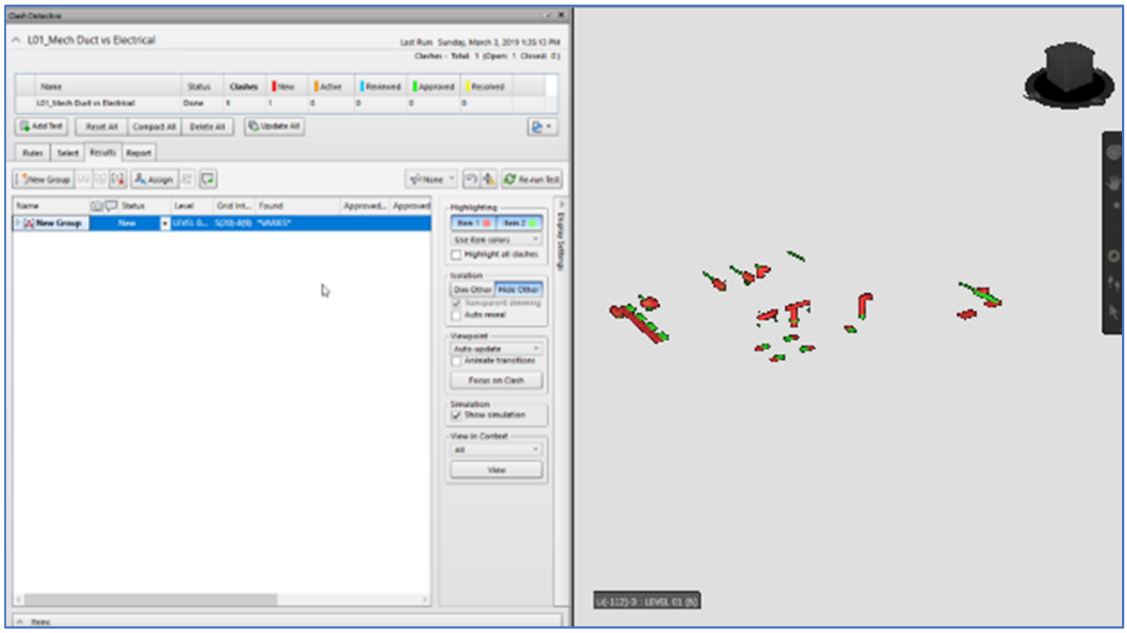


*Image 27. Clash Grouping*

8.4 Clash Grouping

a. Clash grouping is important to leave out any duplicates or irrelevant clashes.

b. Using the Selection Box tool, found under Home>Select, select the region within the grouped clashes to isolate those clashes. This will allow you to isolate a group of clashes and define the type of issues these clashes are generally reporting: False Positive clashes, Major Design Clashes, Minor Design Clashes, or “Approvable” Clashes.

c. After the group of clashes are selected, set the filter selection from *None* to *Inclusive*. This will update the clash list to only show clashes associated with the selected elements. Open the grouped clash tree and select all the clashes in this tree.

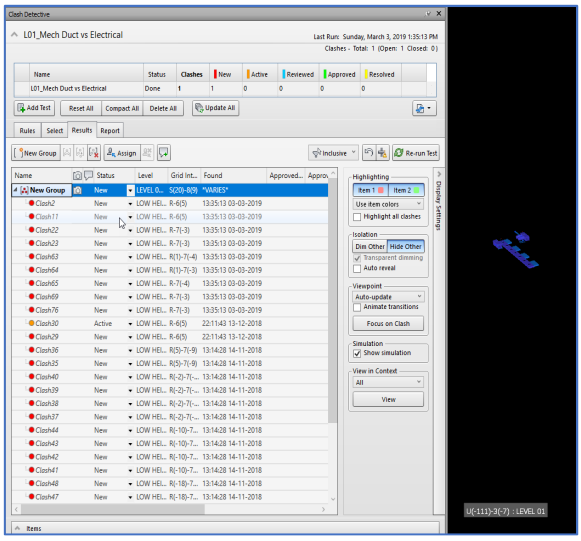


*Image 28. Clash Groups*

# Clash Detection (continued..)

## Step 8: Clash Detection

d. After all the clashes in the grouped tree are selected, click “Remove from Group” to disassociate the clash from the original group.
e. Upon clicking “Remove from Group”, click “Group Selected Clashes” to regroup those selected clashes into a new, separate group.
f. With this new group created with the selected clashes separated out from the individual clash, you may now repeat this process by selecting the original group, setting the view filter back to None, and repeating the steps to group all the clashes within the test.

8.5 Setting Up Clash Viewpoints

a. After all clashes are separated out, each clash should be individually reviewed, and viewpoints set up to provide a more thorough explanation of the context of the clash.
b. Rename each group that you’ve made with a general description of the clash. Any “approvable” clashes should have their status changed to Approved.
c. Navigate through the view in 3D, and disable the *Hide Other* and *Dim Other* isolation view options. Orient your view to a view that shows the clash in a clear way.
d. Once a view is set, right click the clash group and under the camera column, click *Save Viewpoint*. Additional redline mark ups may be added to the view at this point.

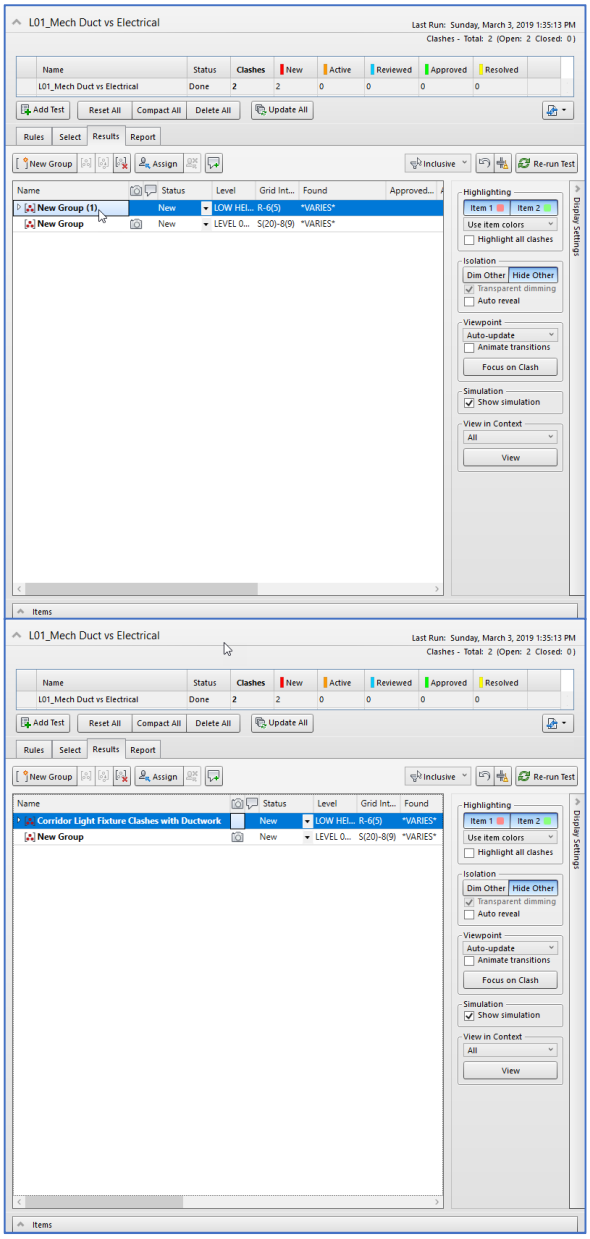



*Image 29. Clash Grouping*

# Clash Detection (continued..)

## Step 8: Clash Detection

### Sample Clash Viewpoints

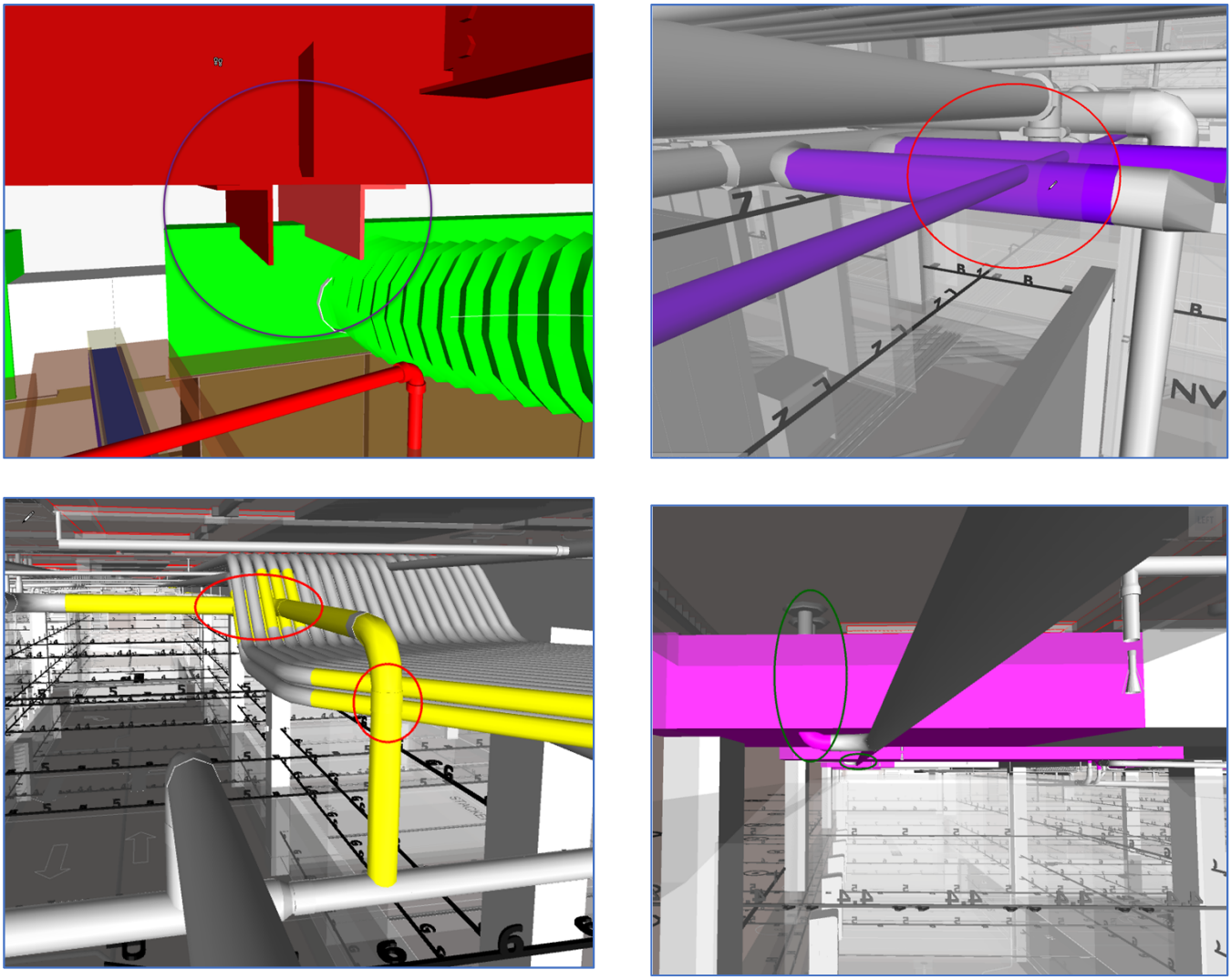


*Image 30. Sample Clashes*

# Clash Detection (continued..)

## Step 8: Clash Detection

8.6 Generating the Clash Report

a. When all clashes have been grouped, viewpoints adjusted, group names renamed, and clash statuses updated, this clash may be generated as a report for others to review.

b. Click on the *Report* tab, and make sure the *Report* type is set to *Current Test*.

c. Set the report format to Viewpoint and have *preserve highlight* checked.

d. Make sure *Reviewed, Approved, and Resolved* statuses are unchecked to ensure clashes that are under this status are not generated as part of the report.

e. Write the report after all settings have been applied.

f. Under the viewpoints window, the resulting viewpoints will be generated and categorized based off the clash test name. Place this report under other folders to better organize your reports and publish this Navisworks model as an NWD for others to utilize and review.

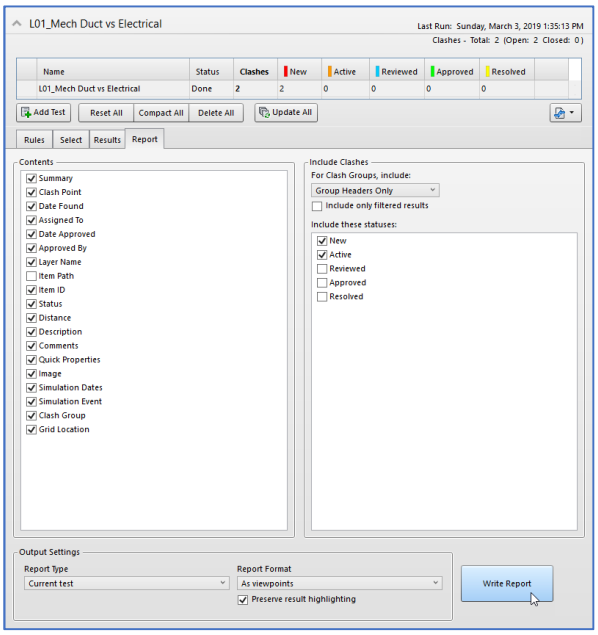



*Image 30. Report Generation*

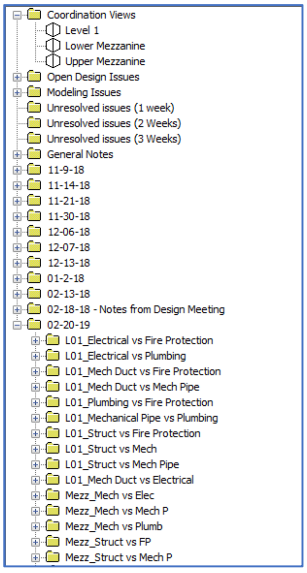



*Image 31. Viewpoints*

# Completing the Executive Summary

## Step 9: Report Findings

Now that each check has been completed, finish the review by summarizing your findings from each tab and overall observations that quickly summarize important information for MPA's review.

9.1 Open the version of *MPA_BIM_QAQC_Template_v1.0.xlsx* that has been used to document report findings.

9.2 Navigate to Executive Summary Tab.

9.3 See section at top of page that states *"Executive Summary:"*

9.4 Summarize your observations of the entire review in 1-3 paragraphs.

9.5 See section at middle of page that states *"Submittal Description."*

a. You will see four colorized boxes with [Enter Text].

b. These boxes are meant for each QA/QC Process Check

i. LOD Check

ii. Clash Detection

iii. Coordinate Check

iv. Point Cloud Validation

c. Summarize each check in one sentence, then change the color of the box (cell) using standard cell format procedure.

d. Change color to the following colors only as shown in excel template.

a. Good = Green

b. Moderate = Yellow

c. Bad = Red

9.6 See section at bottom of page that states *"Files Received."*

a. The white cells are deliverables typically required by MPA.

b. The grey cells, that state *"Select," are drop-downs* for you to select if the deliverable is *Received, Partially Received, or Not Received*.

c. Use findings from *File & Alignment Check* tab to assist in determining if all files were received.

9.7 Once complete, save the Excel report and prepare to transfer excel inputs into PowerPoint template in section *Reporting Review Findings to MPA.*

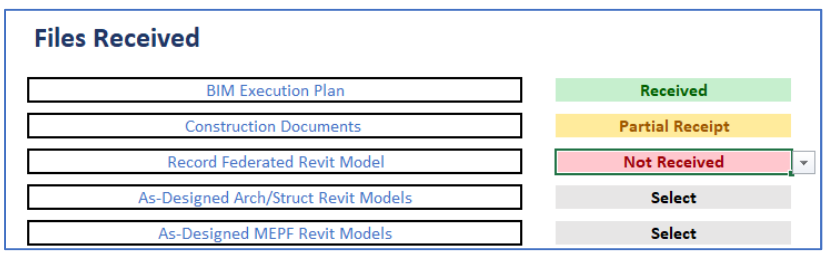



*Image 33. Files Received Table*

# Common Model Issues to Watch Out For

› **Watch out for Imported .DWG files into Revit** - Some Trade As-Built models are .DWG models built in an AutoCAD based program that are loaded into Revit and saved and delivered as “Revit” files. This is problematic because these files cannot be modified in Revit. The native As-Built files are sometimes not included in deliverables.

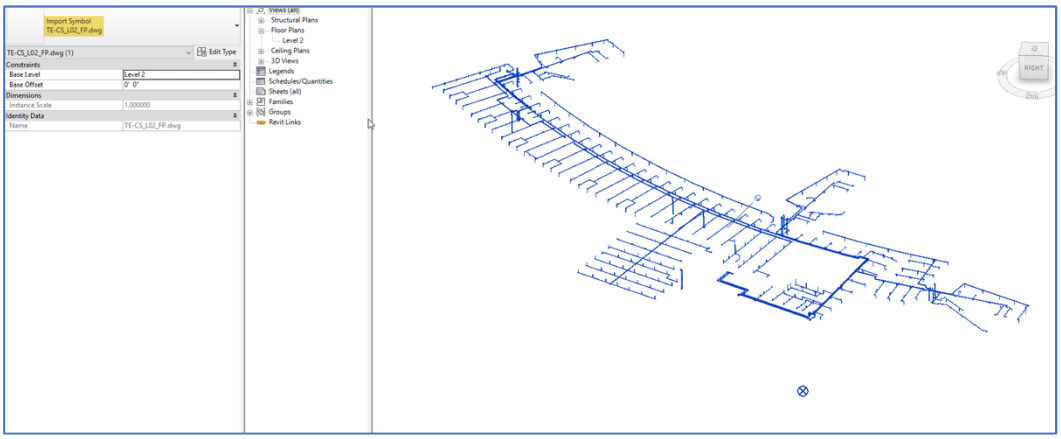


*Image 34. Imported DWGs*

› **Watch out for Items NOT showing up in Revit but are showing up in Federated Navisworks Model -** Some trade as-built models use Revit Fabrication Parts for the majority of the materials and hangers within Revit. This can be problematic as critical equipment might not show up in the Revit file and show systems as disconnected. However, when viewing the Federated Navis Model, equipment and components like toilet carriers may be shown correctly. As a reviewer, this should suggest that the as-built model was developed in another program like Fabrication CADmep and was imported into Revit. CAD blocks typically do not load properly into Revit via .MAJ. See example images below.

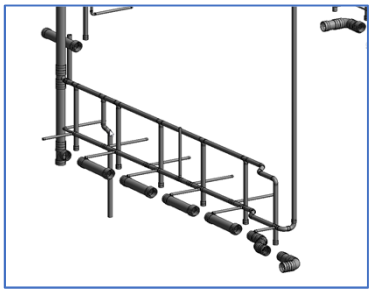


*Image 35. Disconnected piping*

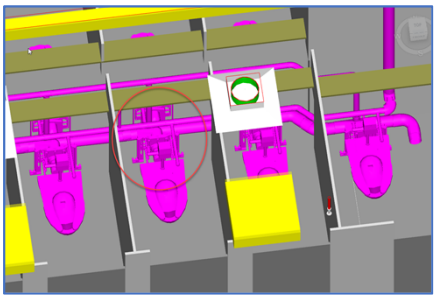


*Image 36. Disconnected fixtures*

## Common Model Issues to Watch Out For

› **Watch out for MEP Services Not Connecting -** This can be attributed to loading Fabrication files into Revit. In many cases, Trade As-Builts have components that do not connect. See example of supply ducting not terminating at the linear supply outlets.

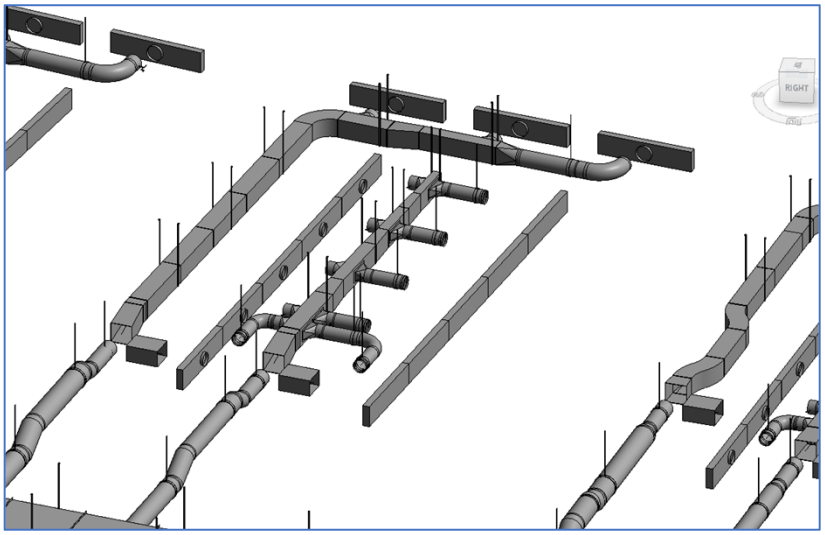



*Image 37. Disconnected Services*

## Process Automation Opportunities

Tools currently exist to help automate some of the QA/QC processes required by Massport.

› **File Name Checker -** Free tool to help reviewer/consultant check and rename files as required. Download: https://franckey.home.xs4all.nl/franckey/software/filenamechecker.htm
› **Autodesk Navisworks:** Model Federation and Semi-Automatic clash detection tool for reviewing of models.
› **Clearedge3D Verity:** Used to semi-automate review of point clouds versus model geometry.

# Reporting Review Findings to MPA

## Step 10: General Instructions

After completing the review using *MPA_BIM_QAQC_Template_v1.0.xlsx,* you will now prepare a printable report using *MPA BIM QAQC Report Template v1.0.pptx* Power Point template. The instructions that follow in this section will provide you with a good understanding of how to use the template effectively.

### 10.1 Documents to Keep Open During Steps 10-16

10.1.1 Open the Excel Review template that you have used to document findings.
10.1.2 Open the *MPA BIM QAQC Report Template v1.0* that is located in QAQC Report template folder.

### 10.2 General Instructions Applicable to Entire PowerPoint Template

10.2.1 Inserting/Replacing Text:

a. Starting at cover page, notice that specific text are highlighted and include a description of what to input.
b. Replace text only for whatever is highlighted. Do not change format or any adjacent text.
c. The text can either be extracted from Excel Template or directly input.
d. Be sure to un-highlight the text when complete.
e. Wherever an “X” is shown, you must also populate a number in order of appearance.

10.2.2 Inserting Pictures

a. Browsing through PowerPoint template, notice that there are specific pages with icons that state *Click icon to add picture.* These icons are placeholders for screenshots or other images saved during review.
b. Be sure to notice any highlighted text below image, this tells you what image needs to be placed.

10.2.3 Modifying/Deleting Pictures

a. Do not modify size or location of placeholders.
b. Prior to printing and submitting report, it is acceptable to delete the unused icons and associated text.
c. For slides that are exclusively for image placeholders, feel free to duplicate the slide if more images placeholders are needed.

# Reporting Review Findings to MPA

## Step 11: Insert Key Plan

On slide 4, page 2 of template, there is a pre-populated key plan example below introduction section. Use the following instructions to find, screenshot, mark-up, and insert into Key Plan Image placeholder.

11.1 Open record architectural drawings in PDF format.
11.2 Locate the titleblock typically found at the far right side of sheet.
11.3 Browse to Project Key Plan section. Boxed in red in image blank.
11.4 Use Snipping Tool to screenshot the key plan. Be sure to not exclude the compass.
11.5 Save the image with no mark-ups to Screenshots folder. This will be used again in step 14.
11.6 With Snipping Tool now open and screenshot ready, using mark-up, circle the primary areas of scope being reviewed.
11.7 Save the image with mark-up to Screenshots folder.
11.8 With PowerPoint Template open, navigate to slide 4, then click the current key plan image to select it.
11.9 Right-click once selected, then locate *Change Picture*. Click, and select *From A File*.
11.10 Locate the Screenshots folder, find the key plan image, select then click open to insert.
11.11 New key plan image will load and be sized to fit in placeholder section.

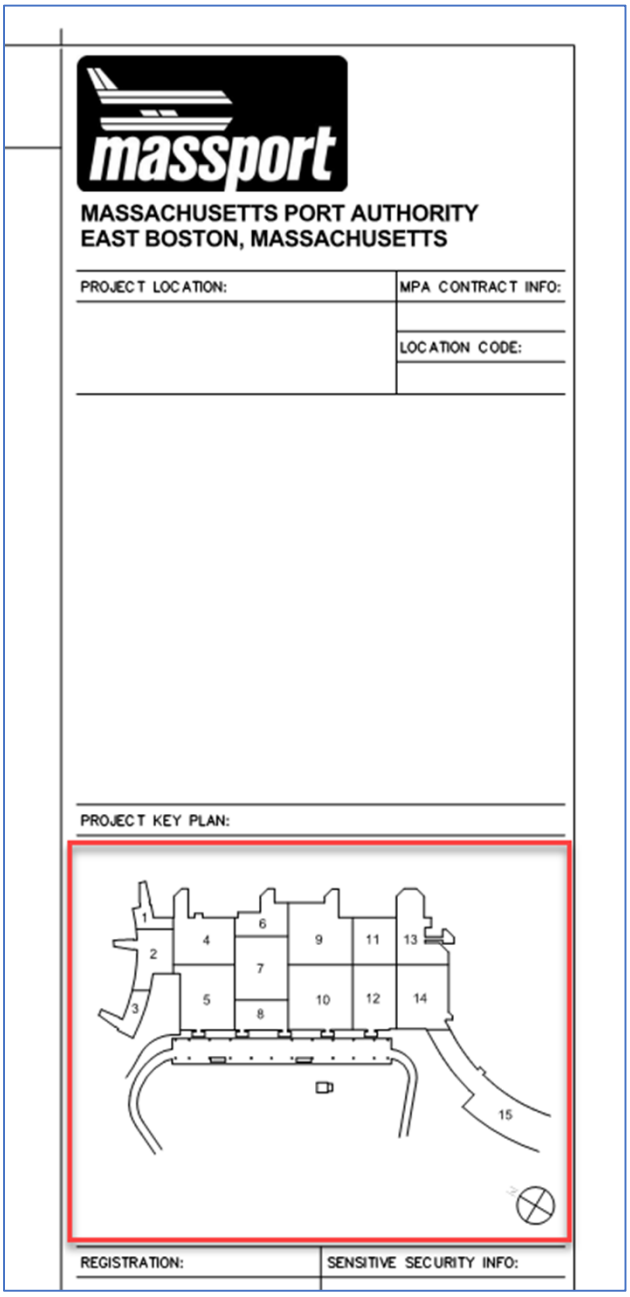



*Image 38. Titleblock Example*

# Reporting Review Findings to MPA

## Step 12: Insert Key Findings

On slide 6, page 4 of template, there are two items to populate. One section is to insert text for key findings and the other is a large icon to add picture from Excel Template. Use the following instructions to populate, find, screenshot, and insert into slide.

12.1 Open Excel template and navigate to *Executive Summary* tab.
12.2 Use Snipping Tool to screenshot area just below Submittal Description. Be sure to include check boxes and files received section in view. See image blank below for example of screenshot.
12.3 Save the image to Screenshots folder.
12.4 With PowerPoint Template open, navigate to slide 6, then *click the icon to add picture*.
12.5 In first section under Key Findings, see highlighted text stating *Insert Key Findings Here*.
12.6 Populate this section with key bullet points to further summarize what is shortly stated in text found in each check box.

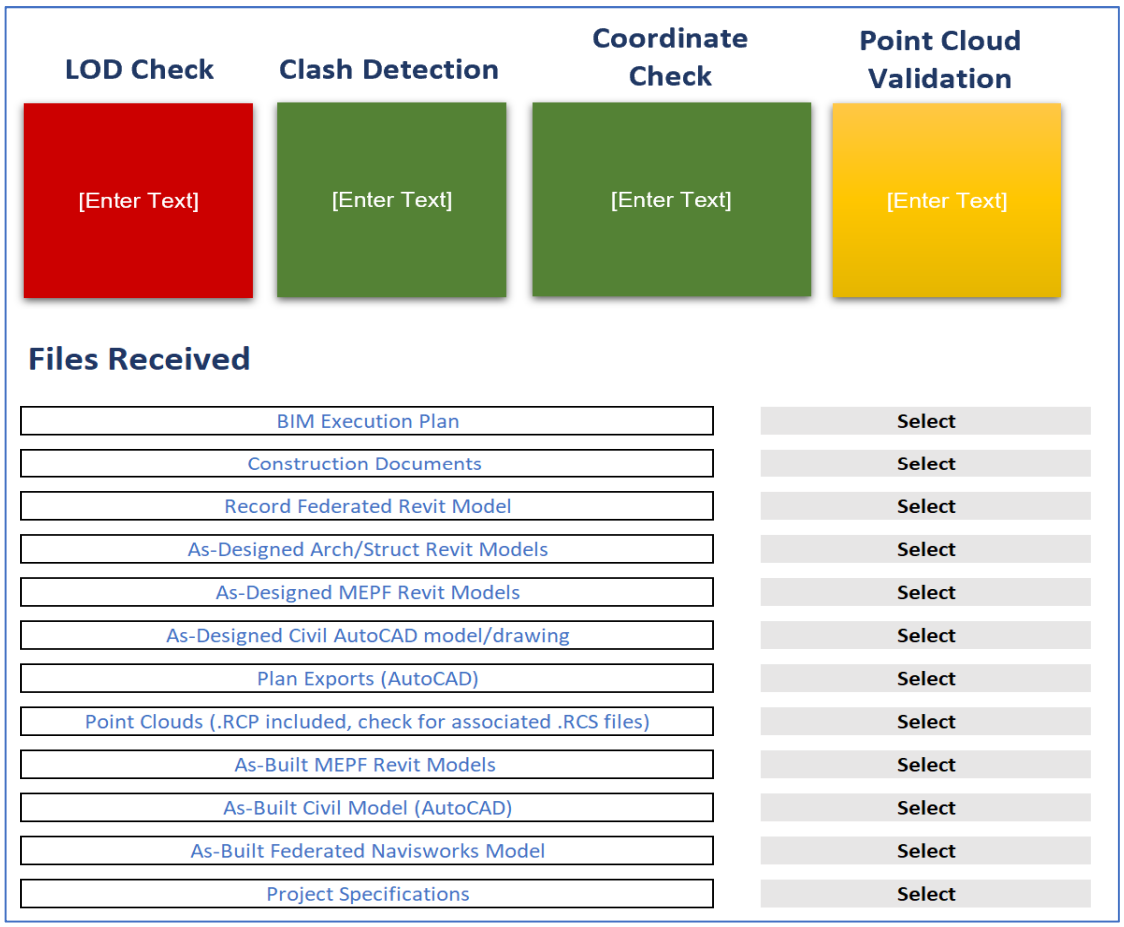



*Image 39. Key Findings Table*

# Reporting Review Findings to MPA

## Step 13: Pasting Excel Data Into LOD Geometry Results Tables

Starting on slide 7, page 5 of template through the end of LOD Geometry Results section, there are tables below each discipline section to populate as shown in example image 39.

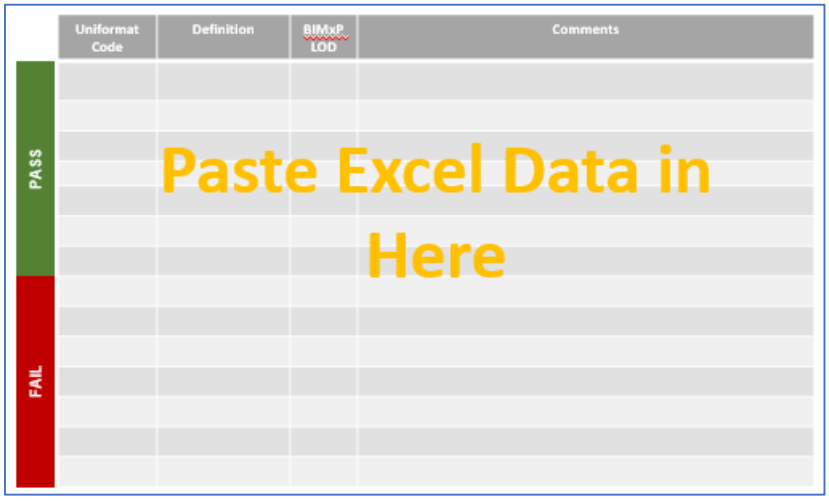



*Image 40. Pasting Excel Data – Template Example*

13.1 Open Excel Template and navigate to Dark Blue tabs found in far right tabs of spreadsheet. As seen in image 40 below.

1.1 SITE INFRA REPORT
2.1 ARCHITECTURAL REPORT
2.3 - STRUCTURAL REPORT
2.4 - HVAC REPORT
2.5 - Plumbing & FP REPORT
2.6 - Electrical Alarm REPORT
3.6 - Mechanical Clear REPORT

*Image 40. Dark Blue Tabs*

13.2 Click on discipline section that you need to paste Pass/Fail excel data. For example, it references Site & Infrastructure Model.

13.3 The Pivot Table should automatically populate data from findings in working tabs.

13.4 Select all cells under columns Uniformat Code, Definition/Condition, BIMxP LOD, and Comments.
   a. Note: Architectural selections may have to be split depending on how many Pass/Fail items.

13.5 With cells selected, Right-Click and Select Copy.

13.6 Go to Powerpoint report and find table to paste Excel data.

13.7 Select top left cell of table, Right-Click and Select Paste>Keep Text Only.

13.8 Excel data should populate without changing format of table.

13.9 Be sure to modify the PASS / FAIL tabs at left of each table. Click and drag notes to pull up and down.

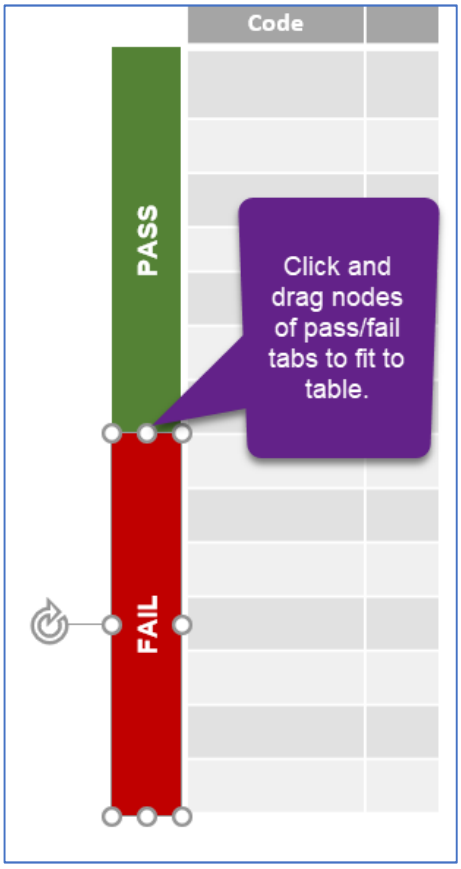



*Image 41. Pass / Fail Tabs*

# Reporting Review Findings to MPA

## Step 14: Insert Key Plan for Clash Detection

On slide 23, page 21 of template, there is a pre-populated key plan example below clash detection section. Use the following instructions to insert Key Plan Image into placeholder and place red circles in clash area that include significant clash results.

14.1 With PowerPoint Template open, navigate to slide 23, then click the current key plan image to select it.
14.2 Right-click once selected, then locate *Change Picture*. Click, and select *From A File*.
14.3 Locate the Screenshots folder, find the key plan image without mark-ups, select then click open to insert.
14.4 New key plan image will load and be sized to fit in placeholder section.
14.5 Delete text above key plan image.
14.6 Insert PowerPoint red circles to embody areas of key plan that have significant clash results.

## Step 15: Insert Clash Results Image for Clash Detection

On slide 25, page 23 of template, there is a pre-populated key plan example below clash detection section. Use the following instructions to insert Clash Results Image to screenshot clash results and insert into current placeholder.

15.1 Open Navisworks document used to perform Step 8.
15.2 Open Clash Detective Tool in Navisworks.
15.3 Expand Clash Detective window so that all columns are visible.
15.4 Use Snipping Tool take a screenshot similar to clash results image provided in template.
15.5 Save to Screenshots in Clash Detection folder.
15.6 With PowerPoint Template open, navigate to slide 25, then click the example clash results image to select it.
15.7 Right-click once selected, then locate *Change Picture*. Click, and select *From A File*.
15.8 Locate the Clash Detection folder, find the clash results image, select then click open to insert.
15.9 New clash results image will load and be sized to fit in placeholder section.

# Reporting Review Findings to MPA

## Step 16: Insert Coordinate Check Image

On slide 26, page 24 of template, there is a large icon to add picture from Excel Template. Use the following instructions to find, screenshot, and insert Coordinate Check image into slide.

16.1 Open Excel template and navigate to *Coordinate Check* tab.
16.2 Use Snipping Tool to screenshot all discipline tabs, arrows, and comments. See example image blank below.
16.3 Save the image to Screenshots folder.
16.4 With PowerPoint Template open, navigate to slide 26, then *click the icon to add picture*.
16.5 If the image is shown zoomed in or cropped, used the following instructions to modify.
   a. Double-left click image, then Format Ribbon should appear and be selected at toolbar.
   b. Click the down-arrow below *Crop.*
   c. Select *Fit.*

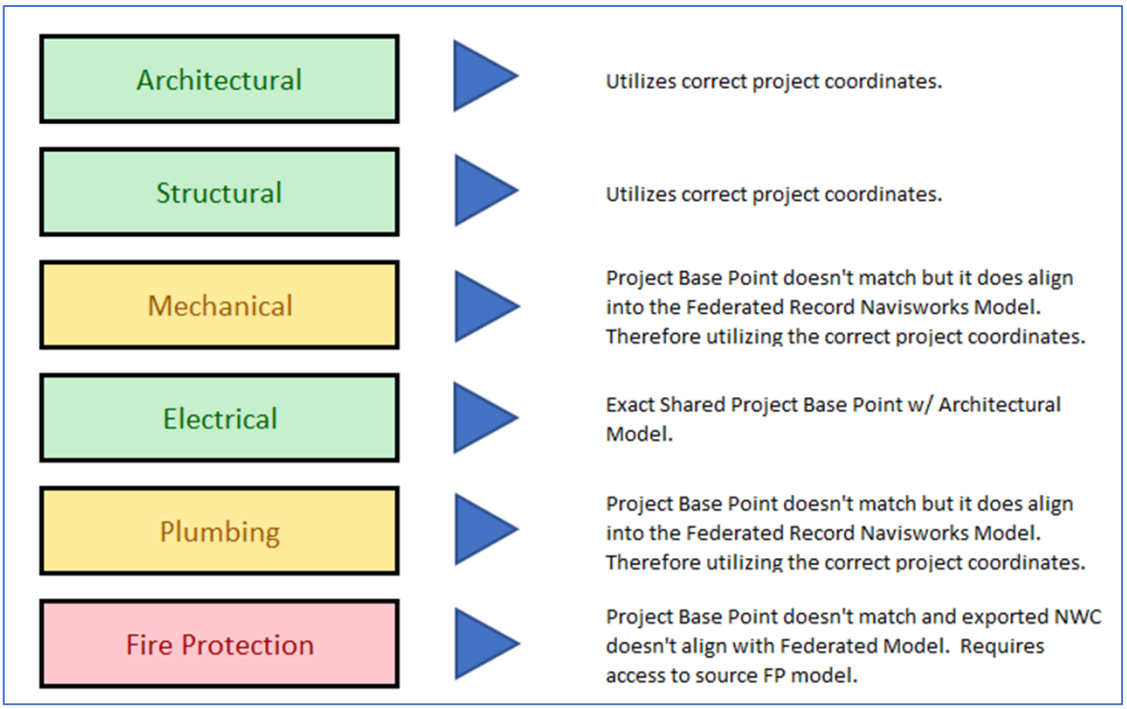

Architectural
Utilizes correct project coordinates.
Structural
Utilizes correct project coordinates.
Mechanical
Project Base Point doesn't match but it does align into the Federated Record Navisworks Model. Therefore utilizing the correct project coordinates.
Electrical
Exact Shared Project Base Point w/ Architectural Model.
Plumbing
Project Base Point doesn't match but it does align into the Federated Record Navisworks Model. Therefore utilizing the correct project coordinates.
Fire Protection
Project Base Point doesn't match and exported NWC doesn't align with Federated Model. Requires access to source FP model.

*Image 42. Coordinate Check Example*

# Reporting Review Findings to MPA

## Step 17: Printing and Submitting

Once report is completed, use the following instructions to print PowerPoint slides, insert Appendices, and submit to MPA.

17.1 Save PowerPoint report using file naming standard set forth by MPA. Be sure the file name is dated.

17.2 Print entire report to PDF using the following settings.

a. Print All Slides > Print Entire Presentation.
b. Full Page Slides > Print 1 slide per page.
c. Collated > 1,2,3  1,2,3  1,2,3.
d. Color

17.3 Open printed PDF report.

17.4 Insert entire Project BIMxP PDF document after Appendix ‘B’ page.

17.5 Save PDF report and submit to MPA.

# Appendix A
# Files Provided for Evaluation (Sample)

A copy of a completed table of Files Provided for Evaluation is inserted after this page.

# Appendix A

# Files Provided for Evaluation

The deliverables shared with the evaluation team includes a mix of Revit As-Designed, As-Built, and Record models, AutoCAD Civil 3D files, As-Built Federated Navisworks Model, Point Clouds (in process), BIM Execution Plan and Construction Documents (Plans Only).

**BIM Execution Plan**

- L1346 - Terminal E_BIMxP - Final.xlsx
- L1346 - Terminal E_BIMxP - Final.pdf

**Construction Documents**

- L1346 Master Drawing List - Final.xlsx
- Individual Sheets from the following packages (not conformed):
  - L1346 - Package 1 - Vertical Circulation - Conformed Set.pdf
  - L1346 - Package 2 - East End - Conformed Set.pdf
  - L1346 - Package 3 - CBP Camera - Conformed Set.pdf
  - L1346 - Package 4 - Early Site Work - Conformed Set.pdf
  - L1346 - Package 5 - Temp Jet Bridge - Conformed Set.pdf
  - L1346 - Package 6 - Site and Structural - Conformed Set.pdf
  - L1346 - Package 6A - Structural Steel - Conformed Set.pdf
  - L1346 - Package 8 - Exterior Envelope - Conformed Set.pdf
  - L1346 - Package 9 - Interior Fit-out - Conformed Set.pdf
  - L1346 - Package 10 - Enhancements - Conformed Set.pdf
  - L1346 - Package 11 - Safe Gate - Conformed Set.pdf
  - L1346 - Package 12 - C2E Elevator - Conformed Set.pdf
  - L1346 - Package 13 - CBP Expansion - Conformed Set.pdf

**Record Revit Models**

- L1346_Terminal E - Renovation and Enhancements_ARCH - Package 10_R18.rvt
- L1346_Terminal E - Renovation and Enhancements_ARCH_R18.rvt
- L1346_Terminal E - Renovation and Enhancements_Federated Record Model_R18.rvt

**As-Designed Revit Models**

- ARCH_Terminal E Existing.rvt
- L1346_Terminal E - Renovation and Enhancements_ELEC_R18.rvt
- L1346_Terminal E - Renovation and Enhancements_FA_R18.rvt
- L1346_Terminal E - Renovation and Enhancements_FP_R18.rvt
- L1346_Terminal E - Renovation and Enhancements_MECH_R18.rvt
- L1346_Terminal E - Renovation and Enhancements_PLUMB_R18.rvt
- L1346_Terminal E - Renovation and Enhancements_SEC_R18.rvt
- L1346_Terminal E - Renovation and Enhancements_SIGN_R18.rvt
- L1346_Terminal E - Renovation and Enhancements_SS_R18.rvt
- L1346_Terminal E - Renovation and Enhancements_STRUC_R18.rvt

**CAD/ Civil3D**

- Airside.zip
- Civil.zip
- Fuel.zip

**Scanned Point Clouds**

- L1346_Terminal E - Renovation and Enhancements_Full Point Cloud.rcp
- L1346 - Terminal E P01 Finished.rcs (not found)
- L1346 - Terminal E P02 Finished.rcs (not found)
- L1346 - Terminal E P03 Finished.rcs (not found)
- L1346 - Terminal E P04 Finished.rcs (not found)
- L1346 - Terminal E P05 Finished.rcs (not found)

# Files Provided for Evaluation (continued…)

**Crescent As-Built Models**

- Electrical:
  - WJG_TERM-E_ELEC_DIST.rvt
- Fire Protection:
  - 360700_FP-Lev00-Area_AB.rvt
  - 360700_FP-Lev01-Area_AB.rvt
  - 360700_FP-Lev02-Area_AB.rvt
  - 360700_FP-Lev03-Area_AB.rvt
  - 360700_FP-Lev04-Area_AB.rvt
- Mechanical Piping:
  - TE-CS_L0B_HP.rvt
  - TE-CS_L01_HP.rvt
  - TE-CS_L02_HP.rvt
  - TE-CS_L03_HP.rvt
  - TE-CS_L04_HP.rvt
  - TE-CS_L05_HP.rvt
- Mechanical Duct:
  - TE-CS_L0B_HD.rvt
  - TE-CS_L01_HD.rvt
  - TE-CS_L02_HD.rvt
  - TE-CS_L03_HD.rvt
  - TE-CS_L04_HD.rvt
  - TE-CS_L05_HD.rvt
- Plumbing:
  - 16-91-PL-Lev-0.rvt
  - 16-91-PL-Lev-01.rvt
  - 16-91-PL-Lev-02.rvt
  - 16-91-PL-Lev-03.rvt
  - 16-91-PL-Lev-04.rvt
  - 16-91-PL-Lev-05.rvt

**East End As-Built Models**

- 356300_PL-Lev02-Area14_AB.rvt
- L1346_Terminal E_MECH - As-built.rvt
- L1346_EL_Terminal E - 2014-as-built.rvt
- L1346_FA_Terminal E - 2014-as-built.rvt
- L1346_SE_Terminal E - 2014-as-built.rvt
- L1346_SS_Terminal E - 2014-as-built.rvt
- L1346_FP_Terminal E_Rybak_3d.rvt
- Misc. 2D .DWG exports also included

**Site As-Built**

- TERM E_SITE AND SITE UTILITIES.rvt
- L1346_Terminal E - As-Built - Site Utilities.dwg

**As-Built Federated**

- L1346_Terminal E - Federated As-Built Model.nwd

**Missing**

- 2D DWG Plan Exports
- Point Cloud .RCS Files
- Project Specifications in PDF

# Appendix B
# BIMxP (Standard Sample)

BIMxP Standard Sample has been inserted after this page.

## Introduction

The MPA requires a project specific BIM Execution Plan (BIMxP) to be developed using this MPA BIM Execution Plan Template. This template documents the project information, roles and responsibilities, tools and communication protocols. The BIMxP also facilitates the identification of BIM specific Lean Conditions of Satisfaction (CoS), aligned BIM Uses, and LOD. This activity is facilitated by a lean value mapping exercise for overall project Conditions of Satisfaction. BIM use is a response to the project CoS, and a method of fulfilling project requirements utilizing BIM. The BIMxP is a living document, and will be accessible, referenced, and updated throughout the project. It is part of the final deliverables of the project. It is the responsibility of the BIM Manager to coordinate the updating and use of this template.

## Goal of the BIMxP:

The goal of the BIMxP is to align Lean CoS goals with BIM Uses, and then determine the most effective BIM development strategy to support the project decision process, and the most efficient modeling effort for Lean project execution.

## Participants:

The design team, the prime BIM Manager and BIM team members, the MPA project manager (PM), the MPA Design Technologies Integration Group (DTIG) Manager, and other project stakeholders.

## BIMxP Contents:

**INTRODUCTION & DATA STANDARDS -** Project standards, definitions and abbreviations used in projects and the pull down menus in the BIMxP. This section provides the team standards for the project.

SECTION 1. PROJECT INFORMATION - Project Information, BIM Execution Plan Approval Signatures, and Contacts

This section provides project name, number, contacts. Project Names and Numbers will be supplied by MPA. Any additional information considered relevant by the PM may be added in this section.

SECTION 2. COLLABORATION PROCEDURES - Meetings, Activities, IT Infrastructure, & Model Submissions

This section provides the strategic and technical procedures for BIM collaboration. This includes model strategy and sharing procedures, model infrastructure, and model submissions. This information is the primary responsibility of the prime BIM Manager in conjunction with the Discipline BIM coordinators. The Model Submission is a jointly reviewed (MPA and BIM Manager) time table for model submissions to MPA for project review. There are three mandatory model submissions during a project, Criteria Definition Model, Design Intent Model Handover, and the Final Submission of the As-Built and Record Model. Other project specific model reviews and deliveries may be documented in this section. Confirm naming of project phases (i.e., 30-60-90)

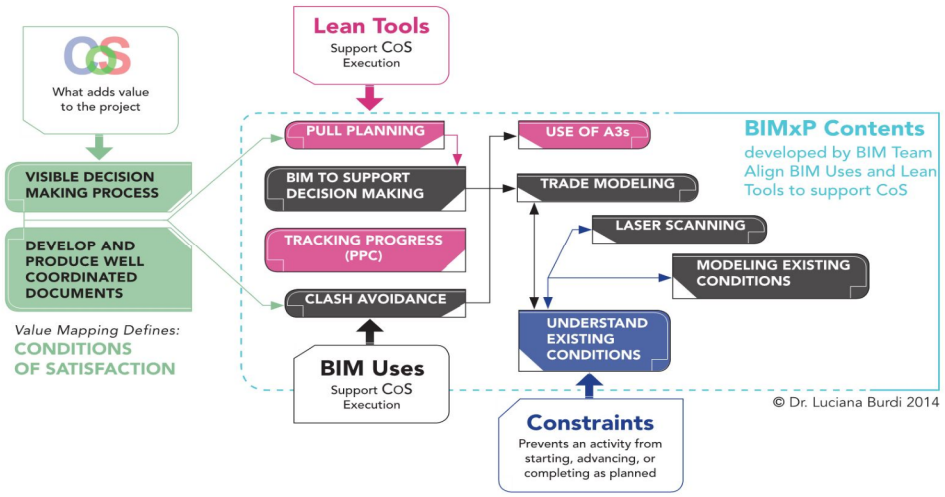
SECTION 3. - BIM CONDITIONS of SATISFACTION (CoS)

The MPA PM or a Lean Facilitator will work with the team and stakeholders to define the project Conditions of Satisfaction. Aligned to these project goals will be BIM specific CoS and BIM actions for execution on the project. This alignment from overall project goals to specific BIM modeling defines the value stream and the Lean BIM process for a project. The prime BIM Manager participates in the CoS meeting and use Section 3 to identify the BIM CoS and activities that add value to the project. The BIM Uses are divided into broad project categories. Not all BIM Uses are applicable to a project. The team will review the automatically identified BIM Uses and rank the priority and final selection.

SECTION 4. - MODEL PROGRESSION - Model Progression, BIM Use Execution, Responsible Parties, and LOD

The Model Progression Worksheet documents the roles and responsibilities, model development, BIM Use execution, and the LOD of model elements. The LOD is a tracking mechanism for MPA. The LOD for elements will be defined at the beginning of each phase and support the highest requirements of the BIM uses to be executed during that phase. At the end of the phase the MPA DTIG manager will review the LOD development and BIM Use execution to determine model progress and adherence to schedule.

## PROJECT SUCCESS PLAN



## DATA STANDARDS - Level of Development (LOD)

The following Data Standards are used or referenced in the MPA BIMxP. Additional information about each standard can be found on the following websites**www.omniclass.org, AGC LOD https://bimforum.org/lod.** Additional Data Requirements for BIM Uses and FM are located within the MPA BIM Guide

## LEVEL of DEVELOPMENT - Associated General Contractors (AGC)

The Level of Development (LOD) Specification is a reference that enables practitioners in the AEC Industry to specify and articulate with a high level of clarity the content and reliability of Building Information Models (BIMs) at various stages in the design and construction process**AGC LOD https://bimforum.org/lod.**

## LOD Definitions

| | | |
|---|---|---|
| **LOD 100** | | The Model Element may be graphically represented in the Model with a symbol or other generic representation, but does not satisfy the requirements for LOD 200. Information related to the Model Element (i.e. cost per square foot, tonnage of HVAC, etc.) can be derived from other Model Elements. |
| **LOD 200** | | The Model Element is graphically represented within the Model as a generic system, object, or assembly with approximate quantities, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element. |
| **LOD 300** | | The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of quantity, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element including finishes, details, reinforcement, and loads. |
| **LOD 350** | | The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of quantity, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element. |
| **LOD 400** | | The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of size, shape, location, quantity, and orientation with detailing, fabrication, assembly, and installation information. Non-graphic information may also be attached to the Model Element. |

## ABBREVIATIONS - Used in MPA Projects / US CAD Standards V5 (Level 1- General Discipline Abbreviations)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Architecture | **A** | Electrical | **E** | Mechanical | **M** | Sub-Con/Shop | **SB** | Contractor/ Shop Draw | **Z** |
| Geotechnical | **B** | Fire Prot. Eng. | **F** | Plumbing | **P** | Specialty Consultant | **SC** | | |
| Civil | **C** | General | **G** | Equipment | **Q** | Telecom | **T** | | |
| Commissioning | **Cx** | Interiors | **I** | Resource | **R** | Tenant | **Tr** | | |
| Process | **D** | Landscape | **L** | Structural | **S** | Survey/Mapping | **V** | | |

## MASSPORT FACILITIES & PROGRAMS

| **Facility Abbreviation** | | **Contract Type Abbreviation** | | **Used in MPA Projects** | | **PM Division Designation** | |
|---|---|---|---|---|---|---|---|
| Logan International Airport | **L** | Construction | **C** | Owner | **O** | Aviation | **A** |
| Worcester Airport | **W** | Design | **D** | Project Mgr. | **PM** | Horizontal | **H** |
| Hanscom Field | **H** | Procurement | **P** | Con Mgr. | **CM** | Seaport/Bridge | **S** |
| Maritime | **M** | Study/Services | **S** | Operations | **Op** | Vertical | **V** |
| Development | **D** | Facility Management | **F** | Hazardous | **Hz** | | |
| Agency Wide | **A** | | | DTI BIM Mgr | **DTI** | | |

## Project Information

| | | |
|---|---|---|
| LAST UPDATED: 20XX.XX.XX | Project Name | |
| | Project Number | |
| | Project Location | |
| | Contract Type | |
| | Contract Status | |

## Project Contacts

| Name | Organization | Role | Email | Phone |
|---|---|---|---|---|
| **Owner** | | | | |
| | | | | |
| | | | | |
| | | | | |
| **Design Team** | | | | |
| **Architecture** | | | | |
| | | | | |
| **Structure** | | | | |
| | | | | |
| **MEP Engineer** | | | | |
| | | | | |
| **Civil Engineer** | | | | |
| | | | | |
| **Parking** | | | | |
| | | | | |
| **Construction** | | | | |
| **Construction Manager** | | | | |
| | | | | |
| **Structural Sub** | | | | |
| | | | | |
| **Mechanical Sub** | | | | |
| | | | | |
| **Electrical Sub** | | | | |
| | | | | |
| **Plumbing Sub** | | | | |
| | | | | |
| **Fire Protection Sub** | | | | |
| | | | | |
| **Specialty Systems Sub** | | | | |
| | | | | |

## Project Schedule Overview

| Milestone | Estimated Start | Estimated Finish | Stakeholders | Comments |
|---|---|---|---|---|
| SD | | | | |
| DD 50% | | | | |
| DD 100% | | | | |
| CD 50% | | | | |
| Equipment Procurement | | | | |
| CD 100% | | | | |
| Commissioning | | | | |
| As-Builts Documentation | | | | |
| Record Documentation | | | | |
| Close Out | | | | |

## Model Exchange

| Information Exchange | One-Time or Periodic | Frequency | Start Date | Method of Transfer |
|---|---|---|---|---|
| Design Model Exchange | Periodic | Weekly + | | |
| Federated Design Review | Periodic | Weekly + | | |
| Subcontractor Model Exchange | Periodic | Daily + | | |
| Federated Sub Clash Reports | Periodic | Weekly + | | |

## Meeting Protocol

| Meeting Type | Phase | Frequency | Participants | Location |
|---|---|---|---|---|
| BIM Execution Planning | Startup | As Needed | A,M,E,P,S,C,CM | |
| Design Assist and Coordination Review | Design Development / Construction Documentation | TBD | A,M,E,P,S,C,CM, MEPFP Subs | |
| MEPFP Coordination | Construction Administration | Weekly | A,M,E,P,S,C,CM, Subs | |
| BIM Close Out | Commissioning | As Needed | A,M,E,P,S,C,CM, Subs | |

## Software for Modeling

| BIM Use | Discipline | Software | Build Number/Service Pack | |
|---|---|---|---|---|
| Site / Civil / Underground Utilities | C | Civil 3D | | |
| Architecture Design | A | Revit | | |
| Structure Design | S | Revit | | |
| HVAC Design | M | Revit | | |
| Plumbing Design | P | Revit | | |
| Electrical Design | E | Revit | | |
| Fire Protection Design | FP | Revit | | |
| Structural Fabrication | S-SUB | | | |
| HVAC Fabrication | M,MP-SUB | | | |
| Plumbing Fabrication | PL-SUB | | | |
| Electrical Fabrication | E-SUB | | | |
| Fire Protection Fabrication | FP-SUB | | | |
| Estimating/QTO | A,S,M,E,P,FP | | | |
| Coordination | A,S,M,E,P,FP | BIM 360 / Navisworks | | |
| 4D Simulations | A,S | | | |

## Model File Naming

| Model Name | Authoring Company | Description/Use | Authoring File Extension |
|---|---|---|---|
| Design Models: *Indicate Central Models | | | |
| CONTRACT_PROJECTNAME_DISCIPLINE | Consultant | | .RVT |
| | | | .RVT |
| | | | .RVT |
| | | | .RVT |

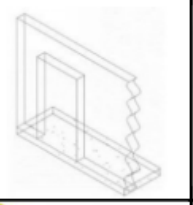
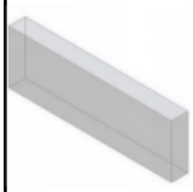
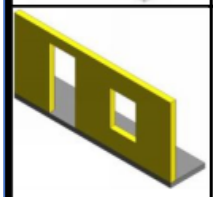
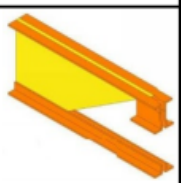
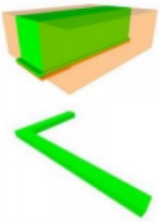
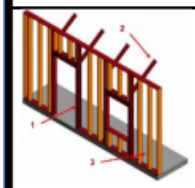
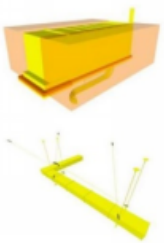
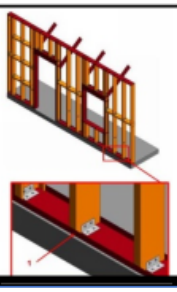
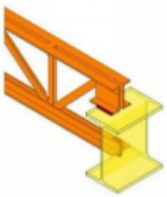
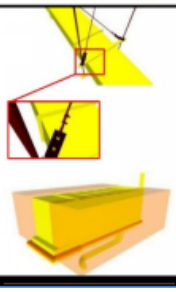
| Stakeholder | Project Conditions of Satisfaction | BIM Uses |
|---|---|---|
| MPA DTIG (Design Technologies Integration Group) | Ensure meeting between MPA PM, MPA DTIG & Primary Design BIM Team early on to ensure clear and precice understanding of expectations and requirements that shall be followed throughout project lifecycle | Laser scan & model existing conditions from established survey control |
| | Regular meetings between MPA PM, MPA DTIG, Prime & CM to go over any BIM updates or changes | Clash during coordination |
| | Deliver to MPA Project Manager & MPA DTIG **all files** at key project milestones in accordance with MPA standards and project BIMxP objectives | Laser scan all as-builts |
| | Ensure quality deliverables of both As-Design and As-Built record files: Revit, CAD, Civil, Navis, Point clouds, PDF, native contractor files | |
| MPA PM | | |
| | | |
| | | |
| | | |
| | | |
| Others… | | |
| | | |
| | | |
| | | |

| | Phases | Design Pkg 1 | | | Construction | | | Facilities Management | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | R/P | Notes | LOD | R/P | Notes | LOD | R/P | Notes | LOD |
| A | | | | | | | | | | |
| | **Foundations** | | | | | | | | | |
| | Standard Foundations | S | | | | | | | | |
| | Special Foundations | S | | | | | | | | |
| | **Subgrade Enclosures** | | | | | | | | | |
| | Walls for Subgrade Enclosures | S | | | | | | | | |
| | **Slabs-on-Grade** | | | | | | | | | |
| | Slabs | S | | | | | | | | |
| B | | | | | | | | | | |
| | **Superstructure** | | | | | | | | | |
| | Floor Construction | S | | | | | | | | |
| | Roof Construction | A | | | | | | | | |
| | Structural Framing | S | | | | | | | | |
| | Structural Columns | S | | | | | | | | |
| | **Exterior Vertical Enclosures** | | | | | | | | | |
| | Exterior Walls | A | | | | | | | | |
| | Exterior Windows | A | | | | | | | | |
| | Exterior Doors | A | | | | | | | | |
| | Exterior Louvers | A | | | | | | | | |

# Appendix C

## BIMForum LOD Standard, Version 2018, LOD Definitions

MPA Guide to BIM VDC on TAA Projects references the below LOD Definitions. Original source: BIMForum LOD Standard, Version 2018. Always refer to the latest BIMForum LOD Standard version. A copy of the latest BIMForum LOD Specification is available on the BIMForum website: http://bimform.org/lod/.

| Architectural | Structural | MEP/FP | |
|---|---|---|---|
|  |  | No Model | **LOD 100** The Model Element may be graphically represented in the Model with a symbol or other generic representation, but does not satisfy the requirements for LOD 200. Information related to the Model Element (i.e. cost per square foot, tonnage of HVAC, etc.) can be derived from other Model Elements. |
|  | | | **LOD 200** The Model Element is graphically represented within the Model as a generic system, object, or assembly with approximate quantities, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element. |
| |  |  | **LOD 300** The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of quantity, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element. |
|  | |  | **LOD 350** The Model Element is graphically represented within the Model as a specific system, object, or assembly in terms of quantity, size, shape, location, orientation, and interfaces with other building systems. Non-graphic information may also be attached to the Model Element. |
|  |  |  | **LOD 400** The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of size, shape, location, quantity, and orientation with detailing, fabrication, assembly, and installation information. Non-graphic information may also be attached to the Model Element. |

VIATechnik worked in collaboration with Massport's DTIG (Design Technology Integration Group) to produce *A Guide for Validating and Checking BIM Submittals*. This joint effort enabled the team to optimize this guide for Massport's unique needs.